SCIENCE ABSTRACTS.

Section A.—PHYSICS.

OCTOBER, 1930.

GENERAL PHYSICS.

3303. Investigation of the Helmholtz Pendulum by the Kathode-Ray Oscillograph. W. Fucks. *Arch. f. Elektrot.* 23. *pp.* 589–592, *May* 30, 1930.

Using a kathode-ray oscillograph supplied with alternating e.m.f. of 500 ∼ the time required to operate the switches of a Helmholtz pendulum was measured under various conditions of adjustment. The operation of the switches produced a discontinuity in the recorded wave-form of the a.c. through an auxiliary circuit. The time-intervals measured in this way varied from 10^{-2} to $2 \cdot 5 \times 10^{-5}$ second. A. B. W.

3304. New Types of Sensitive Silica Manometers. B. Lockspeiser. *Journ. Sci. Instruments,* 7. *pp.* 145–151, *May,* 1930.

The principles of construction of two types of sensitive silica manometers are described. The deflection, to a close degree of approximation, is proportional in one case to the pressure, and in the other to the logarithm of the pressure. Photographs of the instruments and details of the technique involved in their construction are included. AUTHOR.

3305. Direct-Reading Vacuum Meter Depending on the Abnormal Kathode Fall. M. Wellauer. *Arch. f. Elektrot.* 24. *pp.* 4–7, *June,* 1930.

If i is the current through a discharge tube, p the pressure at any time, and p_0 the pressure at which the discharge begins, i is related to p by the formula $i = \mathrm{K}\,(\log p - \log p_0)$, where K is a constant depending on the circuit and the discharge tube. The present instrument makes use of this law to measure pressures between 0·1 mm. and 0·001 mm. of mercury. The discharge tube is connected to the vacuum system, and its electrodes are connected through a resistance of 4 megohms and a milliammeter to the output terminals of a 220/7000-volt transformer at 50 ∼ per sec. The milliammeter readings are calibrated for a given discharge tube by comparison with a McLeod gauge. G. E. B.

3306. Stroboscopic Ripple Tank. W. Baldwin, Jr. *Rev. Sci. Instruments,* 1. *pp.* 309–324, *June,* 1930.

A form of ripple tank is described in which the point source of waves is simply a succession of periodic air blasts directed downwards on the surface of the water. Two or more such sources can be used simultaneously, and their positions are readily changed. For the production of rectilinear waves a pulsating linear vibrator is described. For the study and projection of water waves an adjustable stroboscope is used, which can either be driven in strict synchronism and in any desired phase relation with the air blasts, or slowly advanced in one direction or the other. Thus, the wave images can be made to advance or retreat across the screen and to stop at any desired stage. The series of photographs show some of the possibilities of the device in demonstrating reflection, refraction, interference and diffraction of waves. AUTHOR.

3307. Theory of the Ring Method for Determining Surface Tension. B. B. Freud and H. Z. Freud. *Science.* 71. *pp.* 345–436, *March* 28, 1930. *Am. Chem. Soc., J.* 52. *pp.* 1772–1782, *May*, 1930.

The authors announce that they have developed a theoretical basis for the empirical correction formula of Harkins and his collaborators, making the ring method, as modified, an absolute one, since by it surface tension may be determined without reference to any other method. The basis of the theory is Laplace's equation for stable liquid surfaces expressed in the particular form applicable to surfaces of revolution, with the capillary constant (a^2) eliminated. J. G. H. B.

3308. Determination of Surface and Interfacial Tension from the Maximum Pull on a Ring. W. D. Harkins and H. F. Jordan. *Am. Chem. Soc., J.* 52. *pp.* 1751–1772, *May*, 1930.

Continuing the work of Harkins, Young and Cheng [see Abstract 859 (1927)] the authors make a detailed study of the correction factor F in the equation $\gamma = FP/4\pi R$, in which P is the maximum vertical pull required to free a ring of radius R from the surface of a liquid of surface tension γ. The value of the constant F depends simply upon the geometrical form of the surfaces of the liquid inside and outside the ring and is, therefore, a function of R and r (the radius of section of the ring) and of the nature of the liquid; it is here determined for three pure liquids which wet the ring, using 16 different rings covering a wide range of values of R/r. The pull is measured by a chainomatic balance, and the experimental technique is described in detail. The pull is shown to reach a maximum at a particular position of the ring relative to the surface of the liquid, and all measurements are made with the ring in this position. Values of F are interpolated for integral values of the ratio R/r between 30 and 80 and are given in detailed tabular form as functions of R/r and R^3/V, following the procedure described in the earlier paper; R^3/V is here a dimensionless quantity, V being the volume of liquid upheld by the ring. F varies between 0·75 and 1·12 over the range of variables studied; in the case of the ring used widely with the du Noüy tensiometer ($R/r = 40·55$) F may vary over the range 0·80–1·04 according to the liquid examined. L. V. C.

3309. Surface Tension and Structural Viscosity and Their Bearing upon Chemistry. L. Lorenz. *Zeits. f. Elektrochem.* 36. *pp.* 336–346, *May*, 1930.

Difficulty in accurately defining a liquid has delayed the evolution of a satisfactory theory of the liquid state. The rapid progress now being made in regard to (1) surface structure and (2) bulk structure is described in detail, and its repercussions upon our knowledge of molecular structure is critically discussed under the headings: (1) association, surface-activity, formation and structure of surface films; (2) structural viscosity, as first described by Traube and Whang [see Abstract 662 (1929)] and as investigated more recently in relation to temperature changes, association, mixtures of liquids, etc. Each section has a full Bibliography. L. V. C.

3310. Surface Tension from Measurements of Capillary Rise. A. W. Porter. *Journ. Sci. Instruments,* 7. *pp.* 197–198, *June,* 1930.

A convenient table is provided to facilitate the calculation of capillary constants from the rise of liquids in narrow tubes. AUTHOR.

3311. Hydrodynamics. B. Caldonazzo. *Accad. Lincei, Atti,* 11. *pp.* 400–404, *Feb.* 16, *and pp.* 807–813, *May* 4, 1930.

The fundamental equation of the plane irrotational motions of a perfect liquid is first investigated, and then the relations of the condition of impenetrability of a mobile solid obstacle by the liquid are enquired into. Among other things the motion of a heavy disc in a heavy liquid is determined. A. D.

3312. Formula for the Resistance on a Body in a Fluid. J. M. Burgers. *K. Akad. Amsterdam, Proc.* 33. 5. *pp.* 504–513, 1930.

Oseen and Zeilon have given a formula for the resistance which applies to the case of very small viscosity. This formula is apparently incompatible with the fundamental formula for the resistance derived from Oseen's hydrodynamical theory. The author shows that this discrepancy is attributable to the fact that in Oseen and Zeilon's derivation, the formula for the resistance is deduced by integrating the pressure p over the surface of the body, and in the derivation of p from the q of Oseen's equations, terms of the second degree of the velocities have been taken into account. [See also Abstract 1288 (1930).] J. S. G. T.

3313. Flow of Heavy Fluids. H. Poncin. *Comptes Rendus,* 190. *pp.* 1115–1117, *May* 12, 1930.

Mathematically examines the motion of an incompressible heavy fluid in a vertical plane xOy, in which Oy is the vertical axis. The motion is assumed to be continuous and irrotational. The flow of the fluid for an indefinite side curvature only of a general horizontal direction is considered, in which the motion shows a geometric periodicity. This is obtained with a watercourse in which the irregularities in the vertical direction are periodically reproduced. The conclusions arrived at can be utilised, without essential modifications, for various hydrodynamical problems. R. C. F.

3314. Viscosity of Compressed Gases. J. H. Boyd, Jr. *Phys. Rev.* 35. *pp.* 1284–1297, *May* 15, 1930.

New data and a new theory for the viscosity of compressed gases are presented. Data for nitrogen, hygrogen and a mixture of these gases are given, in the calculation of which the " end effects " are not neglected as has been done in the past. Previous viscosity data are of doubtful validity owing to neglect of this factor. The theory is based on an analogy between the kinetic pressure and viscosity of a gas and is derived using an equation of state of the Lorentz type. Allowance is made for the difference between the viscosity and compressibility covolumes. The theory is substantiated experimentally and further confirmed by the recalculation of other data on the variation of Reynolds' criterion with the pressure, which is here shown to be constant. The mixture data offer a direct opportunity of comparing the Lorentz and linear rules for the calculation of the covolume of a mixture from the covolumes of the components, and such comparison indicates that the Lorentz rule is not to be preferred. The substantiation of the new theory is the first direct proof of the validity of the separate treatment of the kinetic and cohesive pressures in the equation of state. AUTHOR.

3315. Motion of a Perfectly Heterogeneous Fluid. E. Merlin. *Comptes Rendus*, 190. *pp.* 1118–1120, *May* 12, *and pp.* 1225–1227, *May* 26, 1930.

Mathematically examines the general case of the motion of a fluid in rotation showing spiral striations. It is assumed that the forces, referred to unit mass, are obtained from a potential. Notations previously given and functions already established [see Abstract 802 (1928)] are used in the present paper. Further, it is assumed that the physical or mechanical elements, pressure, potential and density, are connected by a relation which is independent of the position of the point in space to which they refer, but possibly dependent on time. The existence is established of perfect fluids in rotation, for which the equal density and equal angular velocity lines have equiangular homothetic spirals as projections on the plane perpendicular to the axis. It is further shown that the formula derived, considering the time as the inverse of the angular velocity, is a constant, and that the angular coefficient of the relation connecting pressure and potential, dependent on the density, is independent of the time. **Errata,** *ibid.* p. 1344, June 11, 1930. R. C. F.

3316. Apparatus and Method for Determining Gas Compressibility and the Correction for " Supercompressibility." H. S. Bean. *Bureau of Standards, J. of Research*, 4. *pp.* 645–661, *May*, 1930.

All gases depart from Boyle's law to some extent, and when industrial fuel gases, known as " natural " gas, are metered at pressures of over 5 or 6 atmospheres, this departure becomes important, and a correction factor, called the " supercompressibility factor," has to be introduced. The experimental method of determining this factor is described, and the derivation of the equation used in computing it from observational data is given. The factor thus determined is said to have an error of about $\pm 0{\cdot}002$. J. G. H. B.

3317. Resistance to Air Flow in High-Vacuum Apparatus. W. Klose. *Phys. Zeits.* 31. *pp.* 503–508, *May* 15, 1930.

The rate of flow of air, under a standard pressure-difference, through tubes of 7 mm. radius is the same whether the tubes be straight or contain right-angle bends or T-joints. The curves obtained on plotting the flow/sec./unit pressure-difference against the mean pressure possess a minimum at 20×10^{-4} mm. Hg, but are linear from 20 to 200×10^{-4} mm. Hg. The rate of flow is also unaffected by the use of taps of the hollow-stopper type if the bore of the taps is equal to that of the tube system; a bore of one-half the diameter of the tubes, however, reduces the flow by 20 %. The flow through an uncooled " freezing-out " vessel consisting of two concentric tubes with an annulus area equal to the area of the central tube is 15–30 % less than that through the standard straight tube, according to the pressure. With the freezer in liquid air fluctuations with time prevent accurate observations from being made. L. V. C.

3318. Critical Loads. G. Krall. *Accad. Lincei, Atti,* 11. *pp.* 564–567, *March* 16, *and pp.* 745–748, *April* 27, 1930.

Treats of critical loads on rods with variable moment of inertia under discontinuity; and shows a simpler mathematical method of dealing with the problem. A. D.

3319. Change of Projectile Trajectory Due to the Earth's Rotation. L. Hänert. *Zeits. f. Physik*, 62. 5–6. *pp.* 419–429, 1930.

The author concludes that v. Eberhard's trajectory [see Abstract

2399 (1930)] is not serviceable as a means of evaluating the influence of territorial rotation upon projectile motion, and also that his formulæ are not free from objection. Charbonnier's formulæ are opined to give more accurate results and are now derived in very simple fashion and applied to the evaluation of change of time and altitude. **O. v. Eberhard** (*ibid.* pp. 429–431) criticises Hänert's assumptions, suggests that they are unsuitable for the purpose in hand, and points out that he has regarded both the classical and Charbonnier formulæ as valid. H. H. Ho.

3320. Forced Vibrations with Combined Viscous and Coulomb Damping. J. P. den Hartog. *Phil. Mag.* 9. *pp.* 801–817, *May*, 1930, *Supplement.*

The free vibrations of a system having a single degree of freedom and affected by a constant friction force are determined by the equations $m\ddot{x} + kx \pm F_0 = 0$, and when a sinusoidal disturbing force is acting on the mass, a steady periodic non-harmonic motion will be set up after a sufficient length of time. Where the friction force is small with respect to the amplitude of the disturbing force, the ensuing motion will be continuous, while for large values of the friction force a single cycle of the motion may consist of regions of motion and of standstill. In this paper an analytical solution has been obtained for motions without standstill, *i.e.*, for sufficiently small damping [see also Abstract 1992 (1926)]. It is found that this solution is valid for such values of the friction and the frequency as are ordinarily met with in engineering applications. H. H. Ho.

3321. Molecular Theory of Elastic Hysteresis. G. A. Tomlinson. *Phil. Mag.* 9. *pp.* 913–935, *May*, 1930.

The theory is based on the hypothesis that the atoms of the material considered are subject to both an attractive and a repulsive force, the latter having a considerably greater rate of change and a much smaller range than the former. Normally the atoms lie at a certain minimum distance apart, when the equilibrium is highly stable. Beyond this distance there is a region of stable equilibrium terminated by the distance for neutral equilibrium. Further separation of the atoms leads to instability; the atoms then re-group themselves, returning to the minimum distance apart with an added kinetic energy representing the hysteresis loss of energy. This theory explains in a general way the amount of energy lost per cycle; also that elastic hysteresis is a process perfectly reversible in the elastic, but not in the thermodynamic, sense. It also accounts for the fact that, under uniform compression, a material does not show hysteresis and throws some light on the fatigue phenomena associated with hysteresis. G. C. McV.

3322. Deformation of the Elastic Medium through the Small Displacement of the Immersed Rigid Sphere. E. Volterra. *Accad. Lincei, Atti,* 11. *pp.* 803–806, *May* 4, 1930.

Discusses Almansi's formula, the translatory displacement and rotations of the rigid sphere, and the general problem of rigid displacement. A. D.

3323. Elasticity of a Rotating Sphere. C. Sunatani. *Tohuku Univ., Technol. Reports,* 9. 2. *pp.* 135–171, 1930. *In English.*

A further investigation [see Abstract 2071 (1930)] of the elasticity of rotating spheres, hollow and solid, the analytical expressions for the displacement, the strain and the stress at a given point of the spheres having already been obtained by the author. In the present paper the deformation, the mode of stress distribution of the spheres and the strength of a rotating solid sphere are precisely treated. The following are the chief results obtained: (1) The deformation of a spherical surface concentric to the boundary surfaces can be expressed by a simple equation in polar coordinates, so that the extension in any radial direction, and consequently the so-called ellipticity, can easily be obtained. (2) The mode of stress distribution of a rotating hollow sphere of finite thickness is illustrated graphically with an example. (3) The modes of stress distribution and of strength distribution of a rotating solid sphere are precisely discussed, the former mode entirely analytically and the latter half analytically and half graphically, and it is shown that these modes vary remarkably according as Poisson's ratio is greater, equal to or smaller than 1/2·633. (4) In a solid sphere the centre is the weakest point, and the speed, at which the sphere starts to fail, may practically be calculated by the formula $\omega = 3/2a_1 \times \sqrt{f_t/\rho}$, where ω, a_1, f_t and ρ are the angular speed, the radius, the tensile strength and the specific weight of the sphere. AUTHOR.

3324. Inharmonic Vibrations in Dynamic Testing of Materials under Alternating Stresses. A. Esau and E. Voigt. *Zeits. f. techn. Physik*, 11. 4. *pp*. 113–114, 1930.

The conditions under which inharmonic vibrations occur in the magnetic alternating stress machine [see Abstract 368 (1929)] are investigated. The resonance curve is influenced by the amplitude of movement of the test-piece, the properties of the material and the distance between the exciting magnet and the specimen, the inharmonic vibrations being more pronounced the greater the amplitude and the smaller the distance of the magnet. With hardened steels the inharmonic vibrations occur at smaller amplitudes than in soft steels. A. J. M.

3325. Optical Method for Determining Internal Tensions in Solids in Three Dimensions. H. Favre. *Comptes Rendus*, 190. *pp*. 1182–1184, *May* 19, 1930.

Small glass prisms with silvered faces are arranged in a block of Pockels glass at points at which tensions are to be determined, and interference effects produced when light traverses the region of any prism are shown by means of an interferometer of the Fabry and Perot type. No experimental details are given. J. S. G. T.

3326. Splitting Strength of Mica. J. W. Obreimoff. *Roy. Soc., Proc.* 127. *pp*. 290–297, *May* 7, 1930.

Thin flakes of muscovite (from Chupa), of thickness 0·1–0·2 mm., were split off by means of a fine glass wedge. Assuming Young's modulus to be 20,000 kg./mm.^{2}, the work done in splitting was determined by an optical method as 1500 ergs/cm.^{2} in air, and 2000 ergs/cm.^{2} *in vacuo*. If the wedge is withdrawn the split-off portion of a flake partially split off unites perfectly with the main portion provided the surface remains uncontaminated. The splitting is accompanied by triboluminescence. C. A. S.

3327. Crystalline Structure of Hydrogen Sulphide and Hydrogen Selenide. Parts I. and II. G. Natta. *Accad. Lincei, Atti*, 11. *pp*. 679–684, *April* 6, *and pp*. 749–754, *April* 27, 1930.

By means of the powder method, in conjunction with a special spectrograph adapted for low temperatures, it is found that solid hydrogen sulphide possesses a cubic unit cell with the side 5·778 ± 0·003 Å. and the volume $192 \cdot 8 \times 10^{-24}$ c.c., containing four H_2S molecules; the calculated density is 1·166. At the same temperature, hydrogen selenide has a cubic cell of side 6·020 ± 0·005 Å. and volume $218 \cdot 2 \times 10^{-24}$ c.c., containing four molecules; the calculated density is 2·456. The two compounds possess analogous lattices of the fluorite type (spacial group O_h5) and, in view of the similarity in structure and dimensions, they are probably perfectly isomorphous. The calculated intensity of the lines of the photograms of the two compounds agree better with the experimental intensities on the supposition of an ionic structure. T. H. P.

3328. Chemical and Crystalline Structure of Certain Complex Nitrites. A. Ferrari and C. Colla. *Accad. Lincei, Atti,* 11. *pp.* 755–760, *April* 27, 1930.

The triple nitrites of potassium and lead with copper, nickel and cobalt respectively crystallise in the monometric system, and contain four molecules in the unit cell. The constants and calculated densities are: $K_2PbNi(NO_2)_6$, $a = 10{\cdot}55$ Å., density 3·50; $K_2PbCo(NO_2)_6$, $a = 10{\cdot}49$ Å., density 3·66; $K_2PbCu(NO_2)_6$, $a = 10{\cdot}52$ Å., density 3·56. The lattice of potassium cobaltinitrite is cubic and of the same type as, and of similar dimensions to, the above: $a = 10{\cdot}32$ Å., calculated density 2·73. The close analogy between these cells indicates, contrary to the current view, that potassium cobaltinitrite contains no water of crystallisation; the water found on analysis must be regarded as water of impregnation of the lattice. The above triple nitrites contain an ion $X(NO_2)_6''''$, where X is most probably copper, nickel and cobalt. T. H. P.

3329. Experiments with Wet Rock-Salt Crystals. E. Schmid and O. Vaupel. *Zeits. f. Physik,* 62. 5–6. *pp.* 311–313, 1930.

In continuation of previous work [see Abstract 3240 (1929)], the authors find practically no change of density and lattice constant to occur on moistening rock-salt crystals, but a considerable increase of hardness, determined by means of a Martens machine, is observed. J. S. G. T.

3330. Arrangement of Micro-Crystals in Compressed Single-Crystal Plates of Aluminium. Part II. Y. Fukami. *Kyoto Coll. Sci., Mem.* 13. *pp.* 229–237, *May,* 1930.

When a single-crystal plate of aluminium is compressed, the micro-crystals produced by the destruction of the single crystal rotate themselves in such a way that their (110) planes, which make the slightest inclination to the flat surface of the specimen, become nearly parallel to the flat surface, by taking the [111], [110] or [112] axis, which is nearly parallel to the flat surface of the specimen, as the axis of rotation. The relation between the maximum angle of rotation of the micro-crystals and the reduction of thickness of the specimen was investigated, and it was found that the maximum angle of rotation occurs at a reduction of about 30–50 % in the thickness of the specimen. As the scattering of the orientation of the micro-crystals is affected by the flow of the metal under compression, the relation between the scattering of the orientations of the micro-crystals and the manner of this flow was also examined with specimens having different shapes. When the specimen in the form of a circular plate is compressed beyond 70 % reduction in thickness, the micro-crystals begin to rotate round the crystallographic [110] axis, which is perpendicular to the flat surface of the specimen. [See also Abstract 887 (1930).] AUTHOR.

3331. Structure of B-Cellulose. J. Eggert and F. Luft. *Zeits. f. phys. Chem.* 7. *Abt. B.* 6. *pp.* 468–470, *May,* 1930.

In the soaked and swollen condition B-cellulose has an amorphous structure, but when dried it shows the X-ray diagram of cellulose. Soaking the dried material in water or alcohol does not restore it to the amorphous condition. When the original wet material is stretched and then dried, a well-marked orientation is observed, the 101 plane always being found in the direction of straining. A. J. M.

3332. Cellulose in the Light of X-Rays. W. H. Bragg. *Roy. Inst., Proc. Advance Proof,* [16 *pp*.]. *Received May,* 1930.

A review of recent work on the X-ray analysis of cellulose. F. J. W.

3333. Crystal Structure of Normal Paraffins at Temperatures Ranging from that of Liquid Air to the Melting Points. A. Müller. *Roy. Soc., Proc.,* 127. *pp.* 417–430, *May* 7, 1920.

Normal paraffins from C_5H_{12} to $C_{30}H_{62}$ are investigated at liquid-air temperature, room-temperature and near the melting point, using a copper anti-kathode ($\lambda = 1 \cdot 539$ Å) and a filter of nickel foil. The higher members of the series crystallise in the normal form irrespective of whether the carbon content is odd or even. Two distinct aspects are considered: (1) thermal expansion, and (2) discontinuous changes of structure. (1) shows that the paraffins are strongly anisotropic. The percentage increase of the *a* and *b* axes is found to be $3 \cdot 5 \pm 0 \cdot 35$. The change in *c* is much smaller and could not be detected. Expansion data indicate that the chain axes move away from each other with rising temperature. From the small expansion of the *c* axis it follows that the molecule itself has a negligible expansion in the direction of its axis, so that the forces holding the atoms together within a molecule are of different magnitude from those keeping the molecules apart. The ratio 3·5 also indicates that the chain molecule has no radial symmetry about its chain axis. Observations in the immediate neighbourhood of the melting point show that the discontinuities (2) are of such a nature that layer structures tend to be formed. F. I. G. R.

3334. Orientations of Molecules in Naphthalene and Anthracene Crystals. K. Banerjee. *Indian Journ. Phys.* 4. *pp.* 557–573, *June* 30, 1930.

The intensities of X-ray diffraction from naphthalene and anthracene crystals do not conform to the orientations of the molecules along any cell face. By the " trial and error " method of analysis it is found that the molecules are inclined to the cell faces, the correct positions being obtained by first placing them along the plane and then by two successive rotations about the " *b* " and the " *c* " axes. The rotations about " *b* " for the two molecules in the unit cell are equal but opposite, while about " *c* " they are in the same direction in conformity with the space-group C^5_{2h}. The rotations for naphthalene are 25° and 12° respectively, and for anthracene 25° and 9°. All the benzene rings in the same molecule are in the same plane and are practically regular hexagons. The structure obtained as the result of the present investigation is in agreement with the magnetic and the optical properties of these crystals. AUTHOR.

3335. Electron Distribution in Magnesium Oxide. E. O. Wollan. *Phys. Rev.* 35. *pp.* 1019–1027, *May* 1, 1930.

The intensity of X-rays reflected from powdered crystals of magnesium oxide was measured for all lines out to $\theta = 45°$. The values of the structure factor F were calculated and plotted against sin θ. Using the values of F from this curve as coefficients in Compton's Fourier series, the radial electron distribution for the atoms of magnesium and oxygen was determined. The electron distribution curves for these atoms are very similar to Havighurst's curves for sodium chloride and sodium fluoride. Although it has been generally conceded that crystals of the magnesium oxide type are polar in form, the data here included are more in line with their being non-polar crystals. However, it is not believed possible from X-ray reflection data to prove definitely this point. AUTHOR.

3336. Complex Character of Nitrogen. A. Smits and J. de Gruyter. *Phys. Zeits.* 31. *pp.* 435–440, *May* 1, 1930.

The present investigation [see also Abstract 1639 (1930)] has been carried out to ascertain whether the complexity of nitrogen can be established at the boiling point of its liquid. Details of apparatus with diagrams and data are given, and the influence of intensive drying is examined. It is concluded that in nitrogen there is a system of two molecular species or pseudo-components giving rise to two solid modifications. H. H. Ho.

3337. Effective Cross-Section and Molecular Structure of Isomerides of C_4H_{10}. E. Brüche. *Ann. d. Physik,* 5. 2. *pp.* 281–295, May 27, 1930.

Results are given of measurements of the effective cross-sections of normal and iso-butanes for six velocities between 0·5 and 7 $\sqrt{\text{volts}}$ by the magnetic method [see Abstract 1324 (1930)]. Between 7 and 1·5$\sqrt{\text{volts}}$ the effective cross-section curves are identical within the limits of experimental error, but for lower values differences appear, these amounting to about 25 % at 0.5 $\sqrt{\text{volts}}$. In agreement with physical data, for small velocities the iso-butane points are lower than the butane. Quantitative comparison of existing physical data indicates that any small differences between the two curves should lie near the experimental error limits, so that interest attaches mainly to the larger deviations at the lower velocities. T. H. P.

3338. Significance of Dipole Measurements for the Stereochemistry of Carbon. E. Bergmann and L. Engel. *Zeits. f. phys. Chem.* 8. *Abt. B.* 1–2. *pp.* 111–137, *June,* 1930.

A general discussion of this question, the principal points considered being: calculation of the dipole moment from the molecule model; the characteristic moments of substituents; regular substituents; disubstituted benzene derivatives; space claim effects with ortho-substituted compounds; irregular substituents—in which the valency direction is not an axis of symmetry—and their mathematical treatment; dipole moments of ethylenes; determination of the configuration of geometrical isomerides; biplanar model of diphenyl deduced from dipole measurements; space claim effects in the chemistry of ethane; fumaroid structure of succinic acid; valency tautomerism between the ethylene and diradical forms of ethylenes. T. H. P.

3339. Group Properties of Dirac's Operators. G. Temple. *Roy. Soc., Proc.* 127. *pp.* 339–348, *May* 7, 1930.

Dirac's equations for the spinning electron in free space may be written

$$\left\{\alpha\frac{\partial}{\partial x}+\beta\frac{\partial}{\partial y}+\gamma\frac{\partial}{\partial z}+\delta\frac{\partial}{\partial ict}+\frac{2\pi imc}{h}\right\}\psi=0,$$

where $\alpha, \beta, \gamma, \delta$ are matrices satisfying $\alpha^2 = 1$, $\beta^2 = 1, \ldots, \alpha\beta + \beta\alpha = 0, \ldots$, and ψ is a four-component wave function. The present paper investigates the properties of all sets of 4 operators, satisfying similar equations to those given above for $\alpha, \beta, \gamma, \delta$. Each such set (perpendicular set) generates a group of order 32, all groups so formed being equivalent to one another. Of the 32 operators in a group, 16 are linearly independent operators, the other 16 differing from the first 16 only in sign. Inserting a perpendicular set of operators in place of $\alpha, \beta, \gamma, \delta$, in the wave equation the law of transformation of the operand ψ is deduced from the invariance of the wave equation. This leads to the determination of the "external properties" of the operators, *i.e.*, the determination of all invariants, 4-vectors and 6-vectors which are quadratic in ψ. W. S. S.

3340. Operational Wave Equation and the Energy Levels of the Hydrogen Atom. G. Temple. *Roy. Soc., Proc.* 127. *pp.* 349–360, *May* 7, 1930.

Using any perpendicular set of operators (A_1, A_2, A_3, A_4) [see preceding Abstract], the operational wave equation for the case of an electron in a central electrostatic field (hydrogen-like atom) becomes

$$\{p_1A_1 + p_2A_2 + p_3A_3 + c^{-1}(p_4 + eV)iA_4 + im_0c\}\psi = 0,$$

where $p_n = -\frac{h}{2\pi}\frac{\partial}{\partial x_n}$, $x_4 = ict$, and V is the potential energy function. It is shown that the "solution" of this equation, *i.e.*, the determination of the eigenvalues of the operator on the left-hand side, can be effected without making any assumptions about the operators A_1, A_2, A_3, A_4, or the wave-number ψ, except that the former form a perpendicular set $\{\frac{1}{2}(A_mA_n + A_nA_m) = o \text{ if } m \neq n, = 1 \text{ if } m = n\}$, and, together with the wave function, satisfy certain straightforward algebraic axioms. The usual approximation to the eigenenergies ϵ for a hydrogen-like atom is obtained in the form

$$\frac{1}{h}(\epsilon - \epsilon_0) = \frac{1}{n^2}RZ^2 + \frac{RZ^4}{n^4}\alpha^2\left\{\frac{n}{|\mu|} - \frac{3}{4}\right\},$$

from which equation and another relation between $|\mu|$ and l, the serial quantum number of non-relativistic quantum theory, the fine structure of the spectrum of hydrogen-like atoms is easily deduced. W. S. S.

3341. Quantum Electrodynamics in the Configuration Space. L. Landau and R. Peierls. *Zeits. f. Physik*, 62. 3–4. *pp.* 188–200, 1930.

Heisenberg and Pauli [see Abstract 2435 (1930)] have recently put forward a quantum theory of the electromagnetic field, using the method of quantised waves. The authors here describe the electromagnetic field, and its reciprocal action with matter, by means of a Schrödinger equation in the configuration space of the light quanta. It has been found that the form of the final equations can be derived by means of a few physically plausible assumptions. The results are identical with those of Heisenberg and Pauli. It has not been possible to get rid of the difficulty that the reciprocal action of a particle with itself comes out as infinitely great, so that the equations are certainly not the physically correct ones; and it does not seem possible to do so by means of a purely formal alteration. H. N. A.

3342. Gauge Invariance in the Wave Equation. E. Reichenbächer. *Zeits. f. Physik*, 62. 5–6. *pp.* 412–413, 1930.

The notion of gauge invariance, first introduced by Weyl for the simultaneous gauging of potentials in gravitational and electromagnetic fields has more recently been applied by him to the discussion of the change of the wave function in Dirac's equation contingent upon change in the latter potential. The author here contends that, possibly owing to the splitting of the electromagnetic potential into two potentials, in his theory, the one type of gauging excludes the other. J. S. G. T.

3343. "Self-Consistent Field" with Exchange for Sodium. V. Fock. *Zeits. f. Physik*, 62. 11–12. *pp.* 795–805, 1930.

With the added assumption of spherical symmetry, the author's generalised theory of Hartree's method of the self-consistent field is applied to the discussion of the dynamics of the sodium atom. The equations for the radial functions, the energy expression and the formulæ for calculating intensities are derived explicitly. The selection rule retains its previous form. [See also Abstract 2448 (1930).] J. S. G. T.

3344. Generalised Statistical Theory. K. K. Mukherjee. *Zeits. f. Physik*, 62. 11–12. *pp.* 855–856, 1930.

The wave-statistical theory developed by Kar and Mukherjee in a recent paper [see Abstract 1334 (1930)] is interpreted, so far as the significance of the damping coefficient is concerned, by reference to the dynamics of two mechanically-coupled systems. J. S. G. T.

3345. Interpretation of Planck's Constant in Connection with Electronic Structure. U. Kakinuma. *Phys. Math. Soc., Japan, Proc.* 12. *pp.* 101–110, *May*, 1930.

Using the expression for the line element arrived at in a previous paper [see Abstract 2415 (1930)], which attributes to the metric inside an electron a wave-like character, the relations between the different constants associated with the electron are worked out. The action integral of the electromagnetic field extended throughout the volume of the electron, and over a time equal to one period of electronic wave, is equated to Planck's constant h, and it then follows that $h\nu = m'c^2$, where ν is the frequency of the electron wave and m' is the mass contained in the volume of the electron (assumed finite). The whole mass of the electron m, which includes the energy outside the electron, is found equal to $4m'$, and for the electron radius the well-known result $2/3 \times e^2/mc^2$ is obtained. A tentative explanation of the proton is advanced on the same lines, *i.e.*, based on the formula $h\nu_p = M'c^2$, where M' and ν_p are the protonic mass and the frequency of the proton wave. W. S. S.

3346. Quantum Kinetics and the Planck Equation. G. N. Lewis. *Phys. Rev.* 35. *pp.* 1533–1537, *June* 15, 1930.

With the same system that Einstein employed [see Abstract 654 (1917)] the Planck equation should issue directly from kinetic principles without the aid of the theory of induced emission. The three fundamental laws of physico-chemical kinetics are (1) the law of entire equilibrium, (2) the law of the duality of elementary processes (or the equality of direct and reverse transition probabilities), (3) the law of equal *a priori* probabilities. It is shown that all three follow from the law of the symmetry of time, and, furthermore, that the first and third of these laws are both derivable from the second. From one of these laws, from the equation of Boltzmann, and from the number of quantum positions in a "Hohlraum" within a given range of frequency, the equation of Planck is immediately derived. Finally, there is a brief discussion of the more general case of thermal equilibrium in a "Hohlraum," when the number of photons is permanently or temporarily restricted, resulting in a state of *grey* rather than of *black* radiation. AUTHOR.

3347. Motion of a Body of Variable Mass. T. Levi-Civita. *Accad. Lincei, Atti*, 11. *pp*. 626–632, *April* 6, 1930.

Generalises the former argument [see Abstract 2068 (1929)] by assuming that the meteorites which vary the mass of a celestial body have their masses and velocities distributed in a Maxwellian manner. E. E. F. d'A.

3348. Principle of Least Action and Gravitation. G. Maneff. *Comptes Rendus*, 190. *pp*. 963–965, *April* 23, 1930.

Shows that it is possible, using the principle of least action of Maupertuis $\delta\int T\,dt = o$, in the modified form $\delta\int mv\,ds_1 = 0$ (T = kinetic energy), to characterise kinematically by means of space and time the independent field of gravitation, which has been characterised dynamically by variable mass, energy and momentum. Refers to previous papers by the author. [See also following Abstract.] H. N. A.

3349. Electromagnetic Energy in the Gravitational Field. G. Maneff. *Comptes Rendus*, 190. *pp*. 1180–1182, *May* 19, 1930.

The author's theory, developed in a previous paper [see preceding Abstract] is extended, and Schwarzschild's expression for the metric, and the expression for the displacement of spectral lines are derived. The theory is characterised by Weyl's geometry and not by that of Riemann and Einstein. J. S. G. T.

3350. Gravitation. U. Crudeli. *N. Cimento*, 7. *pp*. 162–166, *May*, 1930.

Finds a simplification in the problem of the integration of the Einsteinian gravitational equation to a first approximation relative to the empty field. A. D.

3351. Red-Shift and Relativistic Cosmology. H. Weyl. *Phil. Mag*. 9. *pp*. 936–943, *May*, 1930.

The de Sitter solution of the gravitational equations must be supplemented by additional assumptions as to which half of the hyperboloid the actual universe really corresponds. The hypothesis of a common origin of the stars in an infinitely distant past leads to the assumption that the actual universe corresponds to only one-half of the hyperboloid. This justifies the use of coordinates which give a real red-shift due to distance, and this red-shift is calculated. In these coordinates it is possible to have a constant density of matter in the universe, the total mass being infinite. G. C. McV.

3352. Potentials of a Sphere. D. B. Mair. *Phil. Mag*. 9. *pp*. 964–974, *May*, 1930.

Solutions of Einstein's gravitational equations for the case of spherical symmetry, the field being due to a sphere of matter of finite radius. The solutions are carried to the second order of approximation in the quantity L: the product of the mass of the sphere and the gravitation constant. The solutions found are continuous inside and outside the sphere. The paper is mathematical. G. C. McV.

METEOROLOGY, GEOPHYSICS AND ASTROPHYSICS.

3353. Optical Properties of the Atmosphere: Diffusion and Absorption. Y. Rocard. *Rev. d'Optique*, 9. *pp.* 97–111, *March*, 1930.

The author applies a simplification of the electromagnetic theory of light to the problem of diffusion by fairly large particles such as one finds suspended in the atmosphere of maritime or slightly industrial districts. Each individual molecule of a diffusing particle is supposed to act by the electric field of the incident wave itself, while the field of polarisation produced in the same particle is neglected. According to de Mallemann, for an infinite volume this polarisation field to a first approximation is zero, and not as given in the classical value $(n^2 - 1)E/3$. The calculation of diffused light then reduces to a relatively simple interference problem. All properties of diffused light are obtained from one part and of absorption from another part as a function of the mean ray and of the number of diffusing particles. The variation with wave-length (λ) gives the coefficient of absorption as approximately $1/\lambda^{2\cdot5}$. R. S. R.

3354. Method of Investigating the Higher Atmosphere. E. H. Synge. *Phil. Mag.* 9. *pp.* 1014–1020, *May*, 1930.

The method depends on the fact that the scattering of light of wave-length λ by a gas of constant composition and density d varies as d/λ^4. It is suggested that a powerful beam, *e.g.*, of several hundred searchlights, preferably placed at a high elevation, be suitably directed and the light scattered at points along the beam be collected by a parabolic reflector and measured photoelectrically by the author's method of a substituted beam. In this way it should be possible to determine the density of the atmosphere and its variations at heights of the order of 50 km. The difficulties and precautions necessary are discussed. C. A. S.

3355. Distribution of Temperature in the Lower Stratosphere. P. R. K. Rao. *India Meteorolog. Dept., Sci. Notes*, 1. 10. *pp.* 123–136, 1930.

The author analyses the changes of temperature with height in the stratosphere for Batavia and eight stations in the northern hemisphere using the height of the tropopause (H_c) instead of sea-level as the basis of reference. The annual mean lapse-rates show that the stratospheric inversion is 3–4 km. thick in the temperate latitudes, but no limit can be fixed for tropical and sub-tropical latitudes. Diagrams indicate that the stratospheric inversion is in general stronger and thicker in summer than in winter and stronger over higher than over lower H_c. Individual ascents show that the lower the value of T_c the stronger is the inversion in the first 3 km. above H_c and the thicker the inversion above. Correlation coefficients between any two of H_c, T_c and θ_{+3} have been given and their significance discussed. The stratospheric inversion is stronger in lower than in higher latitudes, and at 25 km. the temperature is about 220° Abs. all over the earth. Following Braak, a qualitative explanation is given for the existence of the stratospheric inversion and its latitudinal variation, and for the relationship between T_c and the strength and thickness of the inversion on the basis of convection in the troposphere. R. S. R.

3356. Coefficients of Eddy Viscosity in the Lower Atmosphere. S. Takaya. *Imp. Marine Obs., Kobé, Japan,* 4. *pp.* 1–33, *May,* 1930. *In English.*

The author deals with the lower layer of the atmosphere within which the variations of eddy viscosity (η) occur. The general equations are established, and, using Dobson's observations, the numerical results are set out for spring and summer, for early morning and midday. The value of η increases with height in spring and decreases in summer, while the midday value exceeds the early morning value in both seasons. From the observations at Kasumigaura he finds the spring value three times the winter value, and a large rate of change in spring. The variation for different wind strengths is also given. Using Dobson's data the values of the kinematic eddy viscosity in different seasons, times of day, and wind strengths are comparable with those of Akerbrom, Brunt, Taylor and Hesselberg and Sverdrup, but the Kasumigaura values are smaller. Calculated values for the variations of wind velocity with height agree well with observed values for the early morning in spring and summer up to 400 m. For light winds and the early morning in spring, the increasing coefficient obeys an exponential law, but for moderate winds and the early morning in summer the value is more nearly constant. R. S. R.

3357. Precipitation from Air in Moist-Labile Equilibrium. A. Refsdal. *Geofysiske Publ.* 5. 12. *pp.* 1–71, 1930.

Air is stated to be in labile equilibrium when its temperature gradient lies between 1·0 and 3·41° C./100 m., while the expression " feuchtlabile " is used for the case where equilibrium is stable for unsaturated but labile for saturated air masses, a condition which frequently occurs. In the " feuchtlabile " region the temperature gradient decreases rapidly with temperature and it occurs more frequently in summer than winter and near the surface than above. In the subsequent treatment the author considers: (1) the conditions for stability in the atmosphere; (2) the linear arrangement of local rain and thundery squalls using aerological evidence as indications of fronts in the upper air, the existence of super-adiabatic gradients, and applications of the theory to actual weather charts; (3) the " feuchtlabile " night rain is tested by observations at Ås, and two series of charts; (4) action of local topography; (5) " feuchtlabile " equilibrium and cyclonic activity are considered in two series of charts and the effects of waves and vortices applied; (6) the theory of cyclones is applied to the cases arising in tropical λ, polar and temperate latitudes; (7) the determination of the vertical acceleration and friction for air masses; and (8) the relation of the precipitation to the semi-diurnal wave of pressure. R. S. R.

3358. Persistence of Rainy Days. Anna Eredia. *Accad. Lincei, Atti,* 11. *pp.* 821–824, *May* 4, 1930.

A comparison of statistics, with charts. Each locality seems to have its own law. A. D.

3359. Saturated Adiabatic Changes of State in Supersaturated Ascending Air. M. Robitzsch. *Gerlands Beitr. z. Geophys.* 26. 1. *pp.* 79–91, 1930.

The Hertz tables assume that at the stage of saturation an immediate change occurs from the dry to the saturated adiabatic with reference to a flat water surface. This is unjustified because the drops have a definite radius and supersaturation is required. Relations are obtained for the temperature and density differences in saturated and supersaturated air columns in terms of given differences of pressure. These relations are applied to the conditions existing in cumulonimbus clouds, and it is shown that a horizontal temperature gradient must exist from the ascending core into other parts of the cloud. From these temperature differences conclusions can be drawn regarding the supersaturation of the air, but with existing apparatus the temperatures would be hard to measure. The results are applied also to changes in the drop size in different parts of the cloud, to the formation of castellatus cloud, and to the dissolving away of cloud layers. R. S. R.

3360. Electromagnetic Determination of Dip of Sedimentary Strata. C. and M. Schlumberger. *Comptes Rendus,* 190. *pp.* 1064–1066, *May* 5, 1930.

The electric resistivity of sedimentary strata is less along than perpendicular to the strata, the ratio (λ) of these resistivities being the coefficient of anisotropy. Provided that the strata are not too irregular, the direction and angle (*θ*) of dip can be determined by examining the electric and magnetic fields produced when a current is passed between two electrodes (connected by an insulated conductor) inserted into the earth at two points, A and B, separated by a distance not less than twice the thickness of the superficial disturbed layer. The shorter axis of the equipotential ellipse is the direction of dip, and the ratio of its axes a function of λ and *θ*; but to determine *θ* the potential at some interior point, *e.g.*, in a boring, is necessary. The inclination of the magnetic vector vanishes at a point P if PA coincides with the direction of dip; if perpendicular, it can be determined in terms of λ and *θ*. No details as to methods or nature of the functions referred to are given. C. A. S.

3361. Bibliography of Seismology. E. A. Hodgson. *Dominion Obs. Ottawa, Publ.* 10. *No.* 4. *pp.* 51–65, *Oct.–Nov.–Dec.*, 1929.

3362. Reduction of Gravity Observations. W. Bowie. *Bull. géodésique, No.* 24. *pp.* 210–222, *Oct.–Nov.–Dec.*, 1929. *In English.*

An approximate method for the isostatic reduction of gravity values is worked out. It is exact when applied to cylinders, and avoids the necessity of tables for the effect of compensation of topography. W. A. R.

3363. Reduction of Gravity Observations. E. Soler. *Bull. géodésique, No.* 24. *pp.* 223–229, *Oct.–Nov.–Dec.*, 1929. *In Italian.*

The usual formulæ for the reduction of gravity observations to the geoid and the applications to isostatic calculations are criticised. W. A. R.

3364. The Normal Gravity Formula. G. Silva. *Accad. Lincei, Atti,* 11. *pp.* 641–644, *April* 6, 1930.

Discusses the question of settling the gravity formula by a convention, and in the meantime suggests (giving his reasons for this) the following: $g = 978\cdot049(1 + 0\cdot0052884 \sin^2 \phi + 0\cdot0000059 \sin^2 2\phi)$. A. D.

3365. Spectrohelioscope and Its Work. Part II. Motions of Hydrogen Flocculi near Sunspots. G. E. Hale. *Astrophys. J.* 71. *pp.* 73–101, *March,* 1930.

The purpose of this paper is to describe in detail some of the rapid motions of hydrogen flocculi near sunspots. The observations, to be discussed in a future article of this series, were made visually by the author with a spectroheliscope, which in certain respects is better adapted than other instruments for work of this nature. [For Part I see Abstract 1784 (1930).] AUTHOR.

3366. Spectral Energy-Curve of Sunspots. E. Pettit and S. B. Nicholson. *Mt. Wilson Observat. Contrib. No.* 397. *Astrophys. J.* 71. *pp.* 153–162, *April*, 1930.

The authors describe the apparatus; the general procedure consists of traces with the monochromator slit set on points on the umbra and on the photosphere just north and south of the umbra; a figure gives ratios of spot umbra to photosphere for two spots, and its curve is nearly linear, being slightly convex between λ0·3 μ and λ1·7 μ. The energy-curve of the sunspot (which is the energy-curve of the sun's centre multiplied by the ratio of spot to photosphere) is not that of a black body, and the sunspot has more energy for wave-lengths to the violet of λ0·7 μ. There is little difference in the spectra of photospheric light and those of sunspots below the H and K lines of calcium, suggesting much photospheric light superposed on the spot spectrum; scattering in the earth's atmosphere and the telescope amounts to 8 % or more of photospheric radiation or 16 % of the total spot radiation. The total energy falls continually from the photosphere through the penumbra to the umbra. There is no confirmation of Secchi's observation of a bright periphery to the umbra. The authors obtain comparative temperature data: of the photosphere at centre of the disc, 5955° K.; of the sunspot umbra—(1) from spectral distribution of energy, 4860° K., (2) this corrected for scattered light, 4750° K.; (3) from water-cell absorption, 4720° K. The temperature of the umbra is therefore near 4800° K. A. S. D. M.

3367. Theory of the Solar Corona. E. O. Hulburt. *Phys. Rev.* 35. *pp.* 1379–1383, *June* 1, 1930.

The outer atmosphere of the sun is assumed to be composed mainly of ions and electrons which are actuated by gravitation, radiation pressure and the magnetic field of the sun. By distillation along the lines of magnetic force the particles collect in the lower latitudes of the solar outer atmosphere and by their diamagnetism reduce the magnetic field approximately to zero in this region, leaving a stray field at the poles. Thus, the polar plumes, prominent during sunspot minima, are regarded as owing their form to the magnetic field of the sun. Whereas the wide-spreading structureless coronal luminosity extending out from the lower latitudes is due to an accumulation of ionisation which reduces the magnetic field to a low value and permits the radiation to blow the particles out to great distances. During maximum solar activity there is sufficient ionisation of the outer atmosphere to reduce the magnetic field to a low value even at the poles, and hence the outer atmospheric spray extends roughly equally in all directions, in accord with the appearance of the corona. AUTHOR.

3368. Orbit of the Trans-Neptunian Body. B. Jekhowsky. *Comptes Rendus*, 190. *pp.* 1049–1050, *May* 5, 1930.

The heliocentric distance of the Lowell planet has been calculated by the Lagrange-Andoyer method from the early observations, and again as the observations increased in number, until those of Paris for April 3rd and 17th could be included. The latest values are 44·219 astronomical units for March 25th, and 41·595 for April 2nd, but they will probably decrease as the intervals between observations grow greater. M. A. E.

3369. Predictions of Trans-Neptunian Planets from Perturbations of Uranus. E. W. Brown. *Nat. Acad. Sci., Proc.* 16. *pp.* 364–370, *May*, 1930.

A discussion of the problem as to what are the elements of a planet of given mass and between given limits of distance which will produce small *apparent* perturbations on another planet during a given interval of time, with much larger apparent perturbations outside that interval, leads the author to conclude that the fact that the recently discovered trans-Neptunian planet was found near the place predicted by Lowell is purely accidental. The orbit published by the Lowell Observatory for the newly discovered planet shows definitely that the discovered planet cannot have any connection with the predicted. J. S. G. T.

3370. Determination of the Position and Elements of a Planet or Comet by Three Corresponding Observations of a Small Arc of the Orbit. E. Esclangon. *Comptes Rendus*, 190. *pp.* 1085–1089, *May* 12, 1930. *Bull. Astronomique*, 6. 2. *pp.* 101–114, 1930.

An extension of the method given in an earlier paper [see Abstract 2774 (1930)] is provided in which account is taken of the first and second derivatives of speed and where the arc covered is larger. This arc is of small angular measure, without reference to that described by the earth in the same time, and may be relatively large if the star is distant. It presupposed nothing regarding the heliocentric distance of the star and can be applied to the new trans-Neptunian planet for an arc covering several years. The method is rapid in practice and can be used with calculating machines. R. S. R.

3371. Single Prism Star Spectrograph and Photoelectric Star Photometer on the 25-cm. Reflector at the Berlin-Babelsberg Observatory. P. Guthnick. *Preuss. Akad. Wiss. Berlin, Ber.* 1. *pp.* 3–10, 1930.

3372. Rayton Short-Focus Spectrographic Objective. M. L. Humason. *Mt. Wilson Observat. Contrib. No.* 400. *Astrophys. J.* 71. *pp.* 351–356, *June*, 1930.

Spectra of very faint stars and nebulæ can be observed only with a camera objective of short focus. The California Institute of Technology has a lens of this type, later to be used with the 200-in. telescope, which is an eight-fold enlargement of a microscope objective, with a focal length of 32 mm. and an aperture of 50 mm. or a focal ratio of F/0·6. Tests made at the 100-in. telescope of the Mount Wilson Observatory show excellent definition and a gain of 50 % in speed over the short-focus camera previously used. The spectrograph has a collimator of 24 in. focal length and two light flint prisms. The dispersion at λ4350 is 418 Å. per mm. Ordinary stellar velocities cannot be measured, since the probable error is of the order of 50–100 km./sec.; but an uncertainty of this amount is not important when large displacements, such as those occurring in the spectra of faint extra-galactic nebulæ, are measured. A single nebula in the Ursa Major cluster has been observed in which the apparent velocity-shift is + 11,500 km./sec. The exposure time required was forty-five hours. AUTHOR.

3373. Phosphorus in Stellar Spectra. O. Struve. *Astrophys. J.* 71. *pp.* 150–152, *March*, 1930.

Several absorption lines measured in the spectrum of the star 88 γ

Pegasi, of spectral class B2, have been identified with the strongest lines of P_{III}. The existence of these lines in early class B stars is in agreement with the values of the potentials of ionisation and excitation. The spectrum of P_I has no lines in the photographic region and is, therefore, unknown in stellar spectra. It is possible that several lines due to P_{II} could be found in stars of type A0 or B9. AUTHOR.

3374. Determination of Distribution of Stellar Absolute Magnitudes from Distributions of Angular and Linear Peculiar Velocities. G. Strömberg. *Mt. Wilson Observat. Contrib. No.* 395. *Astrophys. J.* 71. *pp.* 163–174, *April*, 1930.

The method described was devised for the purpose of finding the distribution of stellar absolute magnitudes with high accuracy and with the greatest possible "resolution," however complex this distribution may be. It avoids the use of analytical distribution functions, as well as means and dispersions, and is inductive and entirely numerical. The procedure depends on a knowledge of the distributions of reduced τ-components and peculiar radial velocities V′ for the group of stars studied. The distributions are converted into logarithmic distributions, account being taken of the effect of errors, which is greatest in the case of the smallest values. The new variables are $x = \log \tau + 0{\cdot}2m$ and $y = \log V' - 1{\cdot}6756$. Each distribution is defined by a sequence of frequencies within constant intervals. The unknown distribution of absolute magnitudes is determined by an integral equation. To solve this an approximate distribution of absolute magnitudes M is combined with that of y to give a computed distribution of x. The differences between the observed and the computed distributions of x are formed and used to derive by least-squares corrections to the assumed distribution of M. The corrected distribution of M is again combined with the distribution of y, and the computed distribution of x compared with the observed. The process is repeated until the distribution of x is satisfactorily reproduced. AUTHOR.

3375. Distribution of K and M Stars of Absolute Magnitude Brighter than Sixth Apparent Magnitude as Determined from Peculiar Motions. G. Strömberg. *Mt. Wilson Observat. Contrib. No.* 396. *Astrophys. J.* 71. *pp.* 175–190, *April*, 1930.

The stars are in three spectral groups, K_0–K_2, K_3–K_9, M_0–M_9, numbering 447, 273 and 306 respectively; graphs are given for $x = \log \tau + 0{\cdot}2m$, and tables for $F(x)dx$, $F(y)dy$ and $F(M)dM$, and the final distribution of absolute magnitude is shown graphically. The K_0–K_2 stars give four distinct maxima at $-1{\cdot}8$, $+0{\cdot}2$, $+2{\cdot}9$ and $+6{\cdot}7$ magnitudes, designated respectively "supergiants," "ordinary giants," "subgiants" and "dwarfs," the supergiants being separated from the ordinary by a frequency minimum at $-1{\cdot}0$; there is an extremely rapid rise and fall around the maximum at $+0{\cdot}2$; the ordinary giants are very numerous but confined within an interval of 2 magnitudes; the subgiants as a distinct group of stars is unexpected (probably it is prominent in the G stars). In K_3–K_9, subgiants do not occur; the supergiants are relatively more numerous than in the K_0–K_2 group; no star seems to exist between absolute magnitudes, $+1$ and $+4$. The M absolute magnitudes fall into two distinct groups with maximum frequencies at $-1{\cdot}6$ and $-0{\cdot}1$; there are no subgiants or dwarfs shown within the limits chosen. Stable stellar conditions and relatively rapid translations from one stable state to another are probable. A. S. D. M.

3376. Radial Velocity of R Lyræ. R. F. Sanford. *Mt. Wilson Observat. Contrib. No.* 394. *Astrophys. J.* 71. *pp.* 209–216, *April*, 1930.

The author discusses earlier observations, both photometric, radial and proper motions, and by using 39 radial velocities obtained in 1917, 1923, 1924, 1925 and 1929, he finds that the best agreement fits with a period of 43·48 days, but this is followed by no outstanding spectral changes, nor does it fit in with Mrazek's results giving 41·3 days nor with the indication of a 5-year period from the star's motion in right ascension. For this last he suggests as a cause, at least in part, a systematic difference between the Alleghany and the Mt. Wilson observations. A. S. D. M.

3377. Secular Variation in Stellar Brightness. E. Zinner. *Phys. Zeits.* 31. *pp.* 440–447, *May* 1, 1930.

According to the present theory, evolution is proceeding among the stars, red giants passing gradually through consecutive spectral types to become red dwarfs; but the only way in which such a progression can be proved is by comparing estimates of magnitude at least a thousand years apart, when an actual brightening or fading may become evident. This can be done if we take the estimates of Ptolemy (A.D. 137) and of Al-Sufi (A.D. 964) and compare them with modern estimates, after reducing all to a uniform system, with special regard to the influence of colour and brightness on observation. Ptolemy and Sufi state the brightness in magnitudes and thirds of a magnitude from 1st to 6th. Omitting doubtful stars, such as variables and those with high southern latitude, these ancient estimates have been grouped so as to show the average magnitude ascribed to stars of different spectral type and belonging to the different classes of super-giants, giants and dwarfs; and the result shows clearly that supergiants have increased strikingly in brightness in all spectral classes, dwarfs have strikingly decreased, but giants have changed very little. These stars with secular variation appear to form a link between the variable stars with periods of hours or months, and the majority of stars which show no perceptible change even in 2000 years. M. A. E.

3378. High-Temperature Stars. J. S. Plaskett. *Roy. Astron. Soc., M.N.* 90. *pp.* 616–635, *May*, 1930. *Observatory*, 53 *pp.* 223-229, *Aug.*, 1930. *Abstract.*

These are usually regarded as consisting of the Wolf-Rayet stars and the spectral subdivisions between O5 and B5. Work on these stars at Victoria Observatory has been mainly observation and analysis of the radial velocities, to which have been added data published by other observatories. The group includes stars of the greatest mass, highest luminosity and greatest distance from us. The masses and luminosities deduced from the observations are found to be in good agreement with all other known data about these stars. An analysis of the radial velocities of 995 stars (500 of which were observed at Victoria only) shows that the K term is partly due to group motions of recession in the brighter B-type stars of the southern sky, and partly to the Einstein redward displacement of the spectral lines in massive stars. The solar velocity derived from the group is over 2 km. greater than normal, and the position of the solar apex is over 15° N. and E. of the position determined from the naked-eye stars. The investigation first definitely revealed the existence of diffuse interstellar matter and more recently its uniform distribution and its participation in the galactic rotation. M. A. E.

LIGHT.

3379. Young's Theory of Colour Vision. S. Hecht. *J.O.S.A.* 20. *pp.* 231–270, *May*, 1930.

Discusses objections to Young's theory based by Hering and others upon the unique sensation of yellow, and shows how they can be met by arguments based upon the binocular mixture of colours. E. E. F. d'A.

3380. Laws of Vision. P. A. Macdonald and J. F. Allen. *Phil. Mag.* 9. *pp.* 817–827, *May*, 1930. *Supplement.*

The authors discuss Weber's and Fechner's laws of sensation, and criticise König's measurements with regard to vision. They examine Weber's law with three different spectral colours in an Allen tricolour spectrometer, and they obtain different values for Weber's constant for each colour, but for any given colour Weber's law holds good, the threshold being proportional to the stimulus. E. E. F. d'A.

3381. Sensitive Method for Determining Refractive Indices. S. A. Korff and J. Q. Stewart. *Rev. Sci. Instruments*, 1. *pp.* 341–346, *June*, 1930.

A combination of Michelson interferometer and spectroscope is described which has proved useful in giving accurate values of the refractive indices of vapours, especially near absorption lines. The method involves measurements, easily made, of wave-lengths of fringes seen in the spectroscope. Photographs of the fringes are given. The combination also provides a method for putting along a spectrum a natural scale of frequencies, provided by these fringes. AUTHORS.

3382. Refraction of a Liquid between Two Thin Prisms. M. Masius and W. E. Lawton. *J.O.S.A.* 20. *pp.* 271–278, *May*, 1930.

If a hollow prism is not made up of two plane parallel surfaces, corrections are required to the simple theory for refractive indices where this condition is satisfied. The complete equation is particularly complicated but can be simplified by approximations, the sufficiency of which is tested. If α and β are the angles of the two thin cover prisms and $(\alpha + \beta) < 1$ second, the error in using the simple expression is not greater than 3×10^{-6}, and is, therefore, negligible. If $(\alpha + \beta) = 1$ minute, the probable error in using the simple expression may be 2×10^{-4}. R. S. R.

3383. Atomic Refraction of Nitrogen. K. v. Auwers. *Zeits. f. phys. Chem.* 147. *Abt. A.* 6. *pp.* 436–460, *May*, 1930.

The material available for the derivation of the refraction equivalents of carbimic and iminic nitrogen is considered, and values to be taken for r_α, r_D, $r_\beta - r_\alpha$, and $r_\gamma - r_\alpha$ for each of the groupings, $O-N=C$, $C-N-C$, $H-N=C$, $N-N=C$, $N-CO-R$, and $N-CO-OR$, are recommended. Compounds corresponding with the completely alkylated types $RR'N-N=CR''-C_6H_5$ and $RR'N-CO-R''$ have a smaller specific refractive power than less highly alkylated phenylhydrazones and acid amides; with the hydrazones of the first type the dispersive power also is diminished. The azines exhibit anomalies, the conjugation present in their molecules producing exaltations of the refraction, although the dispersion is scarcely influenced. T. H. P.

3384. Phenomena of Density Oscillations and Dispersion of Light. M. Didlaukies. *Ann. d. Physik*, 5. 2. *pp.* 205–243, *May* 27, 1930.

A theoretical investigation is given of the phenomena of oscillations of density in a gaseous or liquid substance, and a statistic of density oscillations is developed. In the second part of the paper the methods are applied to the dispersion of light, dielectric constants and density. The Kerr effect is also considered. J. J. S.

3385. Optically Empty Crystalline Liquids and Different Species of Liquid Crystals. D. Vorländer. *Phys. Zeits.* 31. *pp.* 428–435, *May* 1, 1930.

Measurements are first given of the density and viscosity for decreasing and increasing temperatures of *p*-ethoxybenzal-*p*-amino-α-methylcinnamic-ethyl ester. In the discussion which follows it is shown that the emulsion hypothesis is as impossible to accept as the swarm hypothesis. It is shown that liquid crystals exist in two species, *viz.*, the optically inactive or feebly active, non-pleochroic forms with double refraction of an optically positive character, and strong pleochroic products with optically negative double refraction. Criteria are discussed for their classification. H. H. Ho.

3386. Optical Rotatory Power of Quartz on Either Side of an Infra-Red Absorption Band. T. M. Lowry and C. P. Snow *Roy. Soc., Proc.* 127. *pp.* 271–278, *May* 7, 1930.

Preceded by a short historical survey of prior work, the authors tabulate the results of observations made in the two series 18,000 to 28,000 Å. and 31,800 to 32,100 Å. The accuracy claimed for the observations is ± 5° corresponding to an uncertainty of ± 0·01° in the rotation per mm. The experimental methods are shortly described, and it is claimed that convincing proof has been obtained of the optical inactivity of one infra-red absorption band and indirect evidence that the others are not sufficiently active for their activity to be demonstrated experimentally. J.G. H. B.

3387. Polarisation Apparatus to Determine the Optical and Magnetic Rotatory Dispersion in the Ultra-Violet. A. Hagenbach. *Helv. Phys. Acta*, 3. 3–4. *pp.* 168–179, 1930. *In German.*

Diagrams and plates are used to illustrate the different parts of the apparatus. A Foucault prism serves as polariser and a calcspar prism as analyser, which, with the quartz prism, produce the dispersion. The place of extinction is recorded photographically and is subsequently measured with a micrometer. R. S. R.

3388. Existence in the Dissolved State of Racemic Components and the Application of Circular Dichroism to the Synthesis of Active Bodies. A. Cotton. *Ann. de Physique*, 13. *pp.* 454–470, *May–June*, 1930.

The author holds that racemic components can exist in solution. He instances the mixing of equal volumes of two like solutions of copper tartrate, one dextro- and one lævorotatory, when a change of colour is seen clearly. Absolute measurements indicate an obvious reaction between the two symmetrical bodies. The author's procedure consists in testing by circularly polarised light the inactive product obtained by chemical synthesis, the constituents showing circular dichroism for the radiation employed. Werner Kuhn and Braun used this method, but obtained only feeble amounts of inactive products. The author examines the precautions necessary to get a clearer separation by this process. Finally, the extension of these researches into the ultra-violet and the production of a quarter-wave plate for this radiation are considered. This problem arises not only for synthesis in circularly polarised light, but also on extending the measurements of circular dichroism into the ultra-violet. [See Abstract 992 (1930).] R. S. R.

3389. Interference Phenomenon Treated by Quantum Mechanics. G. Racah. *Accad. Lincei, Atti,* 11. *pp.* 837–842, *May* 4, 1930.

By the method used by Fermi to study the phenomena of interference of light on the basis of Dirac's theory [see Abstract 1411 (1930)] the author gives a quantistic investigation of the case in which an atom emits by resonance a radiation which interferes with the incident radiation. J. J. S.

3390. Ross' Modification of Hilger Interferometers for Testing Large Optical Elements. O. G. Hay. *Optical Soc., Trans.* 31. 2. *pp.* 91–103; *Disc.*, 103–105, 1929–1930.

The instrument is a modification of the Hilger lens and prism interferometer and is intended for use in testing and figuring large optical elements such as astronomical telescope objectives, coelostat mirrors, etc., where the free aperture of the test element is larger than the normal aperture of the interferometer. A detailed description with drawings of the apparatus for testing optical systems of about 12 in. diameter is given, and the importance of geometrical design of the various parts is emphasised. It is intended to construct the interferometer in order to ascertain the possibilities and limitations of the method and then, with the experience derived from it, to apply the method on a more ambitious scale. AUTHOR.

3391. Stereoscope for Demonstration and Training. Hurault and Mazuir. *Rev. d'Optique,* 9. *pp.* 59–77, *Feb., and pp.* 112–128, *March,* 1930.

The apparatus is designed to illustrate the mechanism of stereoscopic vision and stereoscopic measurements, to demonstrate the principles of action of the apparatus for stereoscopic measurement and the regulations existing in the apparatus to give accuracy. The uses of various parts of the apparatus are explained and their possible relative measurable displacements. Tests on a binocular instrument regarding tolerance, rotation of images, alteration of relief by rotation of the images, and physiological effects in the comprehension of relief are described. It is claimed that the apparatus is of considerable use in training for stereoscopic measurements and for research in measurements of precision. R. S. R.

3392. Anamorphoser with Brewster's Prisms. *Rev. d'Optique,* 9. *pp.* 164–167, *April,* 1930.

Two prisms are mounted to rotate in opposite directions around a common axis. When the adjacent faces are parallel the position is one of minimum deviation and incident and emergent beams are of the same diameter. By rotating the prisms the ratio of the ordinates of the anamorphosed image to those of the primary image is reduced. This arrangement is useful for the systematic deformation of photographic images, the dimensions being modified along any desired direction by rotating the prism system between the parts of the photographic lens. The useful maximum deformation in photography is 4–8 %. R. S. R.

3393. Graphic Symbols in Applied Optics. N. Deisch. *J.O.S.A.* 20. *pp.* 303–312, *May,* 1930.

A system of conventions is introduced to satisfy the needs of instru mental optics. Among the main features are: (1) the use of a given class character to distinguish certain of the larger families of symbols and of progressively altering the parent character to get the desired case differentiation; (2) the use of additions to express such qualifications as material, structure, properties, orientation or relationship; and (3) the inclusion of expressions to denote various types of mechanical freedom. The ground covered includes sources of light, receptions, lenses, prisms, mirrors, apertures, slits and screens. R. S. R.

3394. Sodium-Argon Glow Tube. H. J. Reich. *Rev. Sci. Instruments*, 1. *pp.* 289–291, *May*, 1930.

An account of a source of light which is essentially monochromatic, but which contains a number of visible lines of sufficient intensity to be employed in the calibration of a spectrometer. Sodium is introduced electrolytically into an argon or neon tube, a bath of molten sodium nitrate in a metal crucible being used for the purpose. The crucible is connected through a resistance to the positive side of a d.c. supply of about 300 volts, and either or both of the tube terminals connected to the negative side. On dipping the tube into the molten salt a glow discharge takes place and metallic sodium is deposited on the cooler parts of the interior of the tube. This process is continued for about ten to fifteen minutes. The completed tube is operated on 200–500 volts, with a 50-milliampere, 8000-ohm resistance in series to limit the current. W. C. S. P.

3395. Simple Spectrum Comparator. D. Jack. *Roy. Soc. Edinburgh, Proc.* 50. 2. *pp.* 200–203, 1929–1930.

An instrument is described and illustrated whereby the inconspicuous differences in spectra may be detected, or delicate comparisons of spectra may be made, where it is not convenient to obtain the comparison spectrum on the same plate. It consists essentially of a microscope with two objectives, with an optical arrangement of reflecting prisms such that the two images are brought into the field of view of a single eyepiece, but has the advantage over other similar types, in that it is capable, even if the travel of the microscope is only some 10 in., of examining a portion of a much longer object—for example, a metre scale. J. G. H. B.

3396. Lagrangian Formula for Magnification with the Zeiss-Wild Telescope. P. Wilski. *Zeits. f. Instrumentenk*, 50. *pp.* 321–329, *May*, 1929.

The author provides a geometrical proof of the application of the Lagrangian formula for the magnification with this telescope. R. S. R.

3397. Preparation of Mirrors by Sputtering Metals on Glass Surfaces. A. C. G. Beach. *Journ. Sci. Instruments*, 7. *pp.* 193–195, *June*, 1930.

The paper gives apparatus and details of a method of sputtering metal films on glass or other surfaces for use in interferometers. AUTHOR.

3398. New Ultra-Speed Kinematographic Camera Taking 40,000 Photographs per Second. T. Suhara, N. Satô and S. Kamei. *Tokyo Univ. Aeronaut. Research Inst., Report No.* 60. *pp.* 187–194, *May*, 1930. *In English.*

The authors have recently devised an extremely high-speed kinematographic camera capable of taking photographs at all speeds up to the rate of 40,000 per sec. The normal speed projection, at the rate of 16 pictures per sec., of the prints obtained from these original negatives gives then an apparent reduction of 2500 times in the speed of movement of the object photographed. About 1000 photographic impressions can be taken on a film 4 m. long in this machine. Various photographs of the motion of sound waves inside a cylindrical and an elliptic shell taken with this machine are shown. AUTHORS.

3399. Microscopic and Ultramicroscopic Examination of Microtome Sections of Photographic Layers. K. Schaum and O. Klein. *Zeits. f. wiss. Phot.* 28. *pp.* 43–70, *May*, 1930.

The microscopic study of photographic layers suffers from the disadvantage that it is impossible to obtain sufficiently dense images with the highest magnifications used, whilst it is also very difficult optically to penetrate far enough into the turbid medium of the unfixed plates. This has resulted in the perfection of the usual microscopic methods by the study of microtome sections. Previous authors have used commercial films, or emulsions made expressly for the work, plates rarely being used. The results of the examinations of the structure of photographic layers by other authors are briefly dealt with, whilst a full description of the method used by the present authors is also given. The separation, moistening, mounting of the layer, preparation of the layer for paraffin mounting, recovery and treatment of the sections, and microscopic examinations are considered. In the last section the results of the comparison of illuminated and developed silver nuclei with non-illuminated silver bromide, the effect of development, reduction and intensification of the negatives, the resolving powers, reversal phenomena and colloid colouring of photographic layers are given. These results are found to be opposed to the positive conclusions obtained from the previous examinations described, and it is asserted that there are important difficulties in all the previous authors' methods which give rise to the differences observed. R. C. F.

3400. Spectral Sensitisation of Photographic Emulsions. B. H. Carroll and D. Hubbard. *Bureau of Standards, J. of Research*, 4. *pp.* 693–701, *May*, 1930.

Data are given for sensitisation of three emulsions with pinacyanol-pinaflavol mixtures, with varying concentrations of dyes, and with the addition of pyridine or borax. Pyridine is found to be useful, since it both increases the effectiveness of sensitisation and reduces the tendency to flocculation, which may be a serious difficulty when pinaflavol is mixed with other sensitising dyes. Optimum conditions are bathing for one hour at not over 10° C. in a vertical position with an aqueous bath containing per litre, 4 mgm. each of pinaflavol and pinacyanol and 10 gm. of pyridine. Good results may also be obtained with some emulsions by bathing for three minutes with agitation, with a bath containing, per litre, 10 mgm. each of pinaflavol and pinacyanol and 10 gm. of pyridine. The pyridine must be free from reducing impurities. AUTHORS.

3401. Effect of Grain Size in Photographic Emulsions on the Failure of the Reciprocity Law and a Theory of its Origin. A. P. H. Trivelli and R. P. Loveland. *Eastman Kodak Co. Research Lab. Comm. No.* 426. *Frank. Inst., J.* 209. *pp.* 639–648, *May*, 1930.

Examines experimentally the conclusion of Jones and other investigators that the degree of failure of the Bunsen-Roscoe reciprocity law varies with the grain size, the variation with intensity being greater for the smaller grains. It is found that the smallest sensitivity specks require the most energy of exposure to make them active as developable centres. This means that they would be most influenced by such energy effects as intensity variations. Assuming that the large grains contain most of the larger specks, then the smaller grains would be expected to be most affected by intensity variations. Photoconductivity of the silver halide lattice of the emulsion crystal has been suggested as the basis of photographic sensitivity. The known data regarding the rate of increase of the photoelectric current upon illumination of the emulsion is sufficient to explain the reciprocity failure at high and low intensities. R. C. F.

3402. Quantum Theory of X-Ray Exposures on Photographic Emulsions. L. Silberstein and A. P. H. Trivelli. *Phil. Mag.* 9. *pp.* 787–800, *May,* 1930. *Supplement.*

At first the quantum theory of light exposure on photographic emulsions, based on the assumption that every grain becomes developable with every absorbed light quantum, appeared to represent approximately the observed facts. More rigid scrutiny showed, however, that the deviations between theoretical and experimental results are distinctly systematic, and Silberstein [see Abstract 1570 (1928)] showed mathematically that there is no possible form of the distribution function $f(\epsilon)$ which would give a faithful representation of the experimental findings. The results of further experiments on X-ray exposure of photographic emulsions, considered in accordance with the principle of the theoretical probable deviation, are found to be in close agreement with the theoretical requirements. Comparison of the development of a one-grain-layer plate of a visible-light exposure with one of an X-ray exposure shows that within a few minutes all daylight-affected grains are developed, additional development giving development fog, which increases far more slowly than the number of developed grains. The X-ray-affected grains continue to produce developed grains with increasing time of development in gradually changing rate. Hence the distribution of the X-ray latent image is regarded as haphazard through the entire silver halide grain. T. H. P.

3403. Constant and Intermittent Photographic Spectrophotometry. D. Chalonge and N. T. Zé. *Rev. d'Optique,* 9. *pp.* 145–148, *April,* 1930.

The authors employed a hydrogen tube with aluminium electrodes and obtained photographs of the spectrum on the same plate, half with direct and half with alternating current, using different reductions of intensity. The Lambert-Chalonge microphotometer showed that the curves belonged to the same family, and that the curves of darkening (photographic density as a function of the logarithm of luminous intensity) for various wavelengths for the two groups are superposable. Thus the distribution of energy and the action on a photographic plate are the same for d.c. and a.c. and for large variations in the intensity of the a.c. discharge. R. S. R.

3404. Ultra-Violet Light in the Microscopic Measurement of Particle Size. G. S. Haslam and C. H. Hall. *Frank. Inst., J.* 209. *pp.* 777–789, *June,* 1930.

This article describes the new developments in mounting a pigment for photomicrography, and the use of ultra-violet light for increasing the resolution obtainable when dealing with fine particles. Data are given that illustrate the accuracy gained in the measurement of extremely fine particles by this method. AUTHORS.

3405. Measurements of Photometric Value of Optical Instruments. J. Hrdlička. *Rev. d'Optique*, 9. *pp.* 149–155, *April*, 1930.

After a reference to methods described by Blondel, Odencrants, and Forch and Lehmann, the author describes a method used for a photographic objective based on photographic photometry and giving the loss of light through the apparatus tested. On an optical bench is set up a point source of light at the focus of the objective, the incident beam being limited by a diaphragm. A sensitometer with a photographic plate is placed close behind the objective. Exposures are made with and without the objective and for different distances from the source. Exposures are also made for different positions around the source. By interpolation of the characteristic curve of the photographic plate one obtains the transmission factor and calculates the true effective luminosity of the objective. The method can be applied to other optical instruments such as a telescope or microscope. R. S. R.

3406. Flicker Photometry. L. Piatti. *N. Cimento*, 7. *pp.* 117–127, *April*, 1930.

Describes a new form of flicker photometer. The Elster-Joly block is duplicated. One block is illuminated intermittently by one source of light on one side and by the other source on the other side, the exposures being alternate and not simultaneous. The other block is exposed similarly, but the exposures are so arranged that each source illuminates only one block at a time, *i.e.*, the light from this source falls first on one block and then on the other. The photometric balance is judged by equality of flicker, instead of equality of brightness as in the ordinary Elster-Joly block photometer. The author describes some experiments carried out with the instrument to determine the validity of the flicker method. J. W. T. W.

3407. Spectrographic Analysis of Fluorescence of Vegetable Oils. H. Marcelet. *Comptes Rendus*, 190. *pp.* 1120–1122, *May* 12, 1930.

Examines the emission and absorption spectra of the fluorescence produced by the action of ultra-violet light on vegetable oils. Only olive oil before and after refining, and oils obtained from such sources as olive pulp, sesame, maize, grapestones, earth-nuts, tea-trees and cotton plants, are studied. Band spectra and not line spectra are generally obtained for the fluorescence emission spectra of these oils, and only in certain cases are the edges of the bands sharply defined. All the oils examined are spectrographically dissimilar, and certain mixtures, which are difficult to analyse by other methods, are studied to obtain, if possible, a means of indicating the constituent oils. It is possible to show olive pulp oil in natural or refined olive oil when there are only 5 parts of the former to 100 parts of the latter. Other mixtures, although with larger dilutions of natural olive oil, do not give sufficiently sharp results. The absorption spectra are generally different among themselves, and are also different from the emission spectra. Olive oil, whether natural or refined, shows the same absorption spectra, but with certain of the other oils only a small quantity of ultra-violet light penetrates. R. C. F.

3408. Spectra of Scintillations from ZnSCu. W. Kutzner. *Phys. Zeits.* 31. *pp.* 501–503, *May* 15, 1930.

Continues the study of these scintillations [see Abstract 671 (1928)], using special preparations of known composition containing 1 gm. ZnS, 0·0001 gm. Cu and 0·1 gm. H, where H is the added flux material, consisting of various compounds of the alkali and alkaline earth metals with halogens. It has not been found possible to obtain very definite quantitative results by photographing the spectra, and it is proposed to continue the observations using a photoelectric method. A table is given showing the positions of the maxima of the long and short wave-length bands, with indications as to their relative intensity as given from the photographic records. For the chloride fluxes the positions of the maxima are very similar for all the alkali and alkaline earth metals, but the relative intensities are very different; the maximum of the intensity shifts from the long wave-length to the short wave-length band in proceeding from small to larger atomic weight of the metal; the same is true of the fluorides of the alkline earth metals. Different halogens give different spectra with the same metal in the flux. H. N. A.

3409. Continuous Absorption. J. A. Gaunt. *Roy. Soc., Phil. Trans.* 229. *pp.* 163–204, *May* 13, 1930. *Roy. Soc., Proc.* 126. *pp.* 654–660, *March* 3, 1930.

Continuous absorption in astrophysics has been explained by the transition of electrons from bound states to free states, or from free states in the neighbourhood of ions to other free states of greater energy. The absorption coefficient has been calculated from Kramers' formulæ, which were originally worked out for emission, but which can also be used for absorption, and give good results for X-rays; for light, however, the calculated coefficient is many times smaller than that observed in astrophysics. Kramers used classical electromagnetism, but Oppenheimer has made use of quantum theory on the problem; the approximations used by him in his first paper are unsuitable for stellar applications. The author has, therefore, carried the theory further; he contemplates absorption by an electron in an encounter with a positive nucleus, or by an electron bound to the nucleus, neglecting interference by other electrons, relativity effects and quadripole radiation. The problem is still difficult, and has been solved only in certain limiting cases. In the meantime another paper has been published by Oppenheimer covering the same ground. He finds a value for the absorption coefficient which approaches the astrophysical one, but the author has discovered a mistake in Oppenheimer's work, which brings the two theoretical results into line with one another, and more or less so with those of Kramers, so that the difficulty of the large opacity deduced from observations remains. H. N. A.

3410. Absorption Bands of Ammonia Gas in the Visible Region. R. M. Badger. *Phys. Rev.* 35. *pp.* 1038–1046, *May* 1, 1930.

The article describes an investigation of the absorption spectrum of ammonia gas in the visible region. At 5490 Å. an absorption region was found which was too weak for a complete investigation with the means at hand. On a second band at 6474 Å. measurements on 57 lines are given, and the structure of the band is discussed. These two bands are the fifth and fourth overtones of an ammonia band at $3\,\mu$. Some interesting alternations of intensity are pointed out, and comparison is made with other ammonia bands of the same harmonic series. Some features of other portions of the ammonia spectrum are discussed in connection with the bands here investigated. AUTHOR.

3411. Absorption Spectra of Bismuth and Antimony Vapours. F. Charola. *Phys. Zeits.* 31. *pp.* 457–463, *May* 1, 1930.

The spectra were excited in an electric oven, at temperatures of 800°–

1500° C. for bismuth and 1000°–2300° C. for antimony. The results are in agreement with those of previous workers. The deepest level for bismuth is found to be ^4S and ^2D for antimony. For the former seventeen new terms are found in the arc spectrum and 25 for the latter metal. F. S.

3412. Absorption Spectrum of Chlorine Monoxide. C. F. Goodeve and Janet I. Wallace. *Faraday Soc., Trans.* 26. *pp.* 254–260, *May*, 1930.

From an examination of chlorine monoxide in the region 2200 Å. to 6200 Å. a continuous absorption with apparently no discontinuities has been obtained. Values of the extinction coefficients over this range have also been determined. There are three independent regions of absorption in the spectrum, each of which contains a maximum. These three regions can be interpreted, from thermochemical evidence, as due to the dissociation of the ClO molecule into, first, a Cl molecule and a normal O atom, then into a "chloric oxide" molecule and a normal or unstable Cl atom, and finally into three atoms, the second dissociation being supported by photochemical evidence. In this connection the optical dissociation of ClO_2 is discussed, it being shown that the heat of formation of ClO thus derived agrees fairly well with that obtained from the absorption spectrum of chlorine monoxide. R. C. F.

3413. Absorption of Light by Alkali Halides in Aqueous Solution. H. Fromherz and W. Menschick. *Zeits. f. phys. Chem.* 7. *Abt. B.* 6. *pp.* 439–467, *May*, 1930.

The absorption curves of aqueous solutions of the chlorides, bromides and iodides of lithium, sodium and potassium, and of the chlorides of rubidium and cæsium are determined, from saturation to extreme dilution, in the ultra-violet, and also the absorption curves of some iodides and sodium bromide in the presence of large concentrations of chloride. Previously reported small absorption bands in the near ultra-violet (over 250 mμ) are due to traces of impurity. With increasing concentration the chloride bands are shifted towards the ultra-violet by an amount proportional to the concentration, the bromide bands are slightly broadened, and the iodide bands are markedly broadened to an extent not proportional to the concentration. The maximum of the latter is not shifted up to the highest concentration. In the presence of an excess of chlorine ions the iodide and bromide bands are shifted towards the ultra-violet in proportion to the concentration of chlorine ions. The kations have no appreciable effect on the absorption curves. A. J. M.

3414. Absorption Spectrum of Selenium Vapour. Maria Moraczewska. *Zeits. f. Physik*, 62. 3–4. *pp.* 270–278, 1930.

An account is given of a set of newly measured Se bands obtained with high temperatures and pressures in the long-wave region of the absorption spectrum. The arrangement of the edges of the bands in the series scheme given by B. Rosen is maintained. Two newly found groups of bands in the ultra-violet are investigated in detail. The first, which is situated in the region from 3150 to 2758 Å. and notwithstanding its similarity to the hitherto known series with the shortest waves cannot be treated as its continuation or as a series analogous to it belonging to the same series system, is coordinated with another electron condition of the Se_2 molecule. The coordination of the second group of bands lying in the region from 2300 to 2100 Å. is discussed. J. J. S.

3415. Absorption Spectrum of Sodium Hydride. T. Hori. *Zeits. f. Physik*, 62. 5–6. *pp.* 352–367, 1930.

Describes a newly discovered absorption spectrum in the region between 3680 and 4450 Å. It resembles the multiple line spectrum of lithium hydride described by Nakamura, and belongs to a transition type $^1\Sigma \rightarrow {}^1\Sigma$. The excited $^1\Sigma$ state is characterised by the fact that its nuclear vibrational levels cannot be represented by the formula required by the ordinary theory. An anomaly of a similar kind is also found in the way in which the rotation energies in the excited state depend on the vibrational quantum number. The paper contains numerous tables, with details of the apparently complicated character of the spectrum, which, however, is shown to be in reality of quite a simple nature. H. N. A.

3416. Infra-Red Spectrum of Water Vapour. C. R. Bailey. *Faraday Soc., Trans.* 26. *pp.* 203–211; *Disc.*, 211–212, *April, and pp.* 213–215, *May*, 1930.

This spectrum is discussed in the light of Lütgemeier's formula. The main features of each band in the near infra-red due to rotation are indicated, and the vibration-rotation bands are discussed. Only two fundamental frequencies are required to characterise the spectrum. The molecular model is thought to be triangular. In the *Discussion*, **R. Robertson** agreed that the molecule was probably triangular and should have three frequencies; **C. P. Snow** referred to some work at Bonn which is under way, and in an advance note suggests that the required third frequency has been located; **T. M. Lowry** suggested that the angle between the hydrogens should be greater than 109°; **R. Mecke** stated that he had measured six bands in the region below 1μ with very large dispersion, and has resolved all the bands; the third frequency is found to be just that expected. The author gives reasons for disagreeing with Mecke's argument. He agrees that there should be three frequencies, but states that only two are necessary to describe the spectrum in the region discussed. A. C. M.

3417. Spectra of Trebly Ionised Oxygen and Nitrogen (OIV and NIV). L. J. Freeman. *Roy. Soc., Proc.* 127. *pp.* 330–338, *May* 7, 1930.

The spectrum has been photographed from λ7000 to λ1250 with various instruments. Measurements by Bowen and Mihul are also considered. About 50 lines of OIV have been newly classified and all the doublet and quartet terms of principal quantum number 3 have been identified. In the case of NIV, combinations of the $3p\,^3P$ term with $3s\,^3S$ and $3d\,^3D$ have been observed. Provisional classifications have been given for four other lines. F. S.

3418. Arc Spectrum of Bromine and Its Structure. C. C. Kiess and T. L. de Bruin. *Bureau of Standards, J. of Research*, 4. *pp.* 667–692, *May*, 1930.

The type of spectrum emitted by a Geissler tube containing bromine was found to depend on the pressure of the gas within the tube and the intensity of the exciting discharge. A tube containing the gas at pressures ranging from 10 to 20 mm. Hg emits the arc spectrum, characteristic of the neutral atom, when excited by the uncondensed discharge from a high-voltage transformer. The spectrum produced in this manner was photographed from the ultra-violet to beyond 9300 Å. in the infra-red. More than 300 lines of BrI have been thus recorded and their wave-lengths accurately determined. 60 % of these lines, which include practically all the strong ones, together with those observed by Turner in the Schumann region, have been classified as combinations between terms of the doublet and quartet systems. The terms which have been established are, without exception, those required for BrI by Hund's theory, and arise from adding *s*, *p* and *d* electrons to the basic and metastable terms ^3P, ^1D and ^1S of BrII. Eleven sets of series-forming terms have been found. From these the distance between $^2P_2$, the basic term of BrI, and $^3P_2$, the basic term of BrII, has been calculated as 95,550 cm.$^{-1}$, which gives an ionisation potential of 11·80 volts for the neutral bromine atom. AUTHORS.

3419. Active Nitrogen. Part VIII. (i) Influence of Photogens and of Surfaces on Glow Phenomena in Nitrogen; (ii) Effects of Addition of other Gases to Luminous Nitrogen. E. J. B. Willey. *Chem. Soc., J. pp.* 1146–1157, *May*, 1930.

Further experiments [see Abstract 2834 (1930)] show (i) that introduction of a photogen after nitrogen has been sparked induces the after-glow in pure nitrogen, (ii) that a strong glow appears if the same gas is placed in contact with a paraffin-waxed surface and (iii) that the amount of chemical reaction between the wax and the active nitrogen is much less in photogenic than in non-photogenic nitrogen. These results are considered to furnish proof of the correctness of the theory that photogens are wall-poisons and convert the non-luminous heterogeneous reassociation of atoms into a homogeneous reaction accompanied by emission of light. Experiments on the addition of other gases to the after-glow yield results in accordance with the three-body collision theory of the emission of the after-glow, provided that the condition of the walls is such that they do not interfere. T. H. P.

3420. New Measurements on Fourth Positive Bands of Carbon Monoxide. L. B. Headrick and G. W. Fox. *Phys. Rev.* 35. *pp.* 1033–1037, *May* 1, 1930.

New measurements of that part of the fourth positive band system of carbon monoxide between 2174 Å. and 1280 Å. have been made from plates photographed with a 1 m. vacuum spectrograph. Low-voltage arc excitation was used. The densities of the band edges were determined from a microphotometric trace. A few new band edges lying below the fourth positive system are reported. In general the measurements are in good agreement with the wave-lengths published by Birge [See Abstract 1384 (1927)]. AUTHORS.

3421. Structure of the Lithium Line 6708. A. Bogros. *Comptes Rendus*, 190. *pp.* 1185–1187, *May* 19, 1930.

This is the first line of the principal series of lithium (symbol 2S–2P). The author has studied it by using an atomic jet of lithium vapour to absorb light passing through it at right angles to the direction of motion of the atoms, which are thus free from the effects of electric and magnetic fields and of collisions, the Doppler effect being also much reduced. Two principal components were photographed (the $2S{-}2P_{1/2}$ and $2S{-}2P_{3/2}$ lines of Li7), the distance between them being 0·150 Å.; the distance between the faint satellite (line $2S{-}2P_{1/2}$ of Li6) and the large wave-length component of the principal doublet (line $2S{-}2P_{1/2}$ of Li7) was 0·156 Å. The first of these measurements agrees with previous results, the second seems to be the first accurate determination of the position of the satellite. The fourth component which is theoretically present

$(2S–2P_{3/2}$ of Li6) is too close to $(2S–2P_{1/2})7$ to be separated. The relative intensity of the satellite is of the right order. H. N. A.

3422. Rarefied Sodium Flames. H. Ootuka. *Zeits. f. phys. Chem.* 7. *Abt. B.* 6. *pp.* 407–421, *May*, 1930.

Earlier work on flames of sodium burning in chlorine, in iodine vapour and in $HgCl_2$ is followed up by investigations on flames of sodium burning in bromine and in $HgBr_2$. $Na + Br_2$ flames show the following characteristics (Type I): (1) weakening of the flame when overheated; (2) the output of light increases, at a greater rate than linearly, with increasing sodium pressure; (3) the luminosity curve is broad. From the overheating it is calculated that the heat of dissociation of the sodium molecule is 19 k.cal., while the most probable value from other lines of attack is 18·5 k.cal. From the light output is deduced that the number of light-quanta emitted during the reaction $Na_2 + Br \rightarrow NaBr + Na$ is from 0·5 to 1. It is concluded that every collision $Na_2 + Br$ is fruitful. The sodium $+ HgBr_2$ flames show the characteristics of Type II, namely, no weakening of the flame due to overheating, output of light increases with increasing sodium pressure more slowly than linearly, and the luminosity curve is narrow. One elementary process, $HgBr_2 + Na \rightarrow Hg + NaBr$ gives rise to 0·12 light-quanta. The " cross-section " in collisions when sodium atoms are excited by nascent NaBr molecules is equal to the kinetic theory cross-section. [See also following Abstract.] A. C. M.

3423. Rarefied Potassium-Halogen Flames. H. Ootuka. *Zeits. f. phys. Chem.* 7. *Abt. B.* 6. *pp.* 422–438, *May*, 1930.

In a flame of potassium vapour, in which some sodium is mixed, the D-lines dominate the visual appearance. Measurements made in this light allow conclusions to be drawn as to the mechanisms of the reactions $K + Cl_2$ and $K + Br_2$. These flames belong to Type I. The heat of dissociation of K_2 (possibly it is here KNa) is 12·5 k.cal. The flames experimented upon contained 7 % (molecular) of sodium vapour added to the potassium. [See also preceding Abstract.] A. C. M.

3424. Band Spectra of Zinc and Cadmium Vapours. S. Mrozowski. *Zeits. f. Physik*, 62. 5–6. *pp.* 314–330, 1930.

The absorption and emission spectra of zinc and cadium vapours are determined and their relation to the somewhat similar band spectrum of mercury discussed. The band series discovered by Mohler and Moore in the case of the absorption spectrum of zinc is completed and its convergence limit determined. Other matters discussed include the effect of temperature upon the fluorescent band spectrum of cadmium vapour, the best conditions for the excitation of the emission band spectra of the vapours by the electric discharge, and the origins of the spectra. J. S. G. T.

3425. Mean Lives of Lines of Mercury Triplet $2^3P_{012} - 2^3S_1$. R. H. Randall. *Phys. Rev.* 35. *pp.* 1161–1169, *May* 15, 1930.

The mean life of each of three lines coming from the same upper level in the mercury atom has been measured. The triplet $2^3P_{012} - 2^3S_1$ was excited by electron impact under conditions involving negligible ionisation and concentration of excited atoms. The method was that previously described by Webb, in which h.f. voltages are applied in phase to the excitation and detecting systems. The lines were excited in a sealed-off tube with mercury pressures between 0·004 and 0·03 mm. The exciting voltage was less than 10 volts. The excitation was such that there was no appreciable concentration in the 2P states. A specially designed potassium-hydride photoelectric cell was used as the detecting system. Optical filters were used to isolate the line measured. The results agree with the assumption that the radiation decays exponentially after impact. For the lines λ4047 and λ4358 the lives were found to be the same within the experimental error (0·75 %), *viz.* $\tau = 5{\cdot}75 \times 10^{-8}$ sec. The value for λ5461 was four times greater, $\tau = 2{\cdot}37 \times 10^{-7}$ sec. The agreement between the lives of λ4047 and λ4358 supports the quantum assumption that lines coming from the same level in the atom have the same life. Collins has found that under certain exciting conditions the fine structure of λ5461 is anomalous as compared to λλ4047 and 4358. It is suggested that the longer life found for λ5461 may be explained by considering the fine structure of the 2^3S_1 level. The results are then consistent with the above assumption. AUTHOR.

3426. Possible Origin of the Band at 2540 Å. in the Spectrum of Mercury Vapour. R. Rollefson. *Phys. Rev.* 35. *pp.* 1177–1179, *May* 15, 1930.

It can be shown that the band at 2540 Å. in the spectrum of mercury vapour can be accounted for on the basis of a molecule with low energy of dissociation, in agreement with the work of Koernicke, who used this band to determine the heat of dissociation of Hg_2. Certain possibilities are suggested for explaining the high value of the heat of dissociation obtained by Mrozowski [see Abstract 3318 (1929)]. AUTHOR.

3427. Concentration of Metastable Mercury Atoms. E. Gaviola. *Phys. Rev.* 35. *pp.* 1226–1230, *May* 15, 1930.

The concentration obtained of metastable atoms in the presence of 3 mm. of nitrogen, using the measurements of Stuart, seems to be in contradiction with a calculation given here, using observations of Wood. The contradiction disappears if the different statistical weights of the levels 2^3P_1 and 2^3P_0 are taken into account. Corrected curves for the number of metastable atoms as functions of the foreign gas pressure are given for CO, H_2O, N_2, A and He which are to replace the corresponding curves of the previous paper. It is shown that the assumption of the author that by high primary light intensities the number of metastable atoms increases only with the square root of the intensity is strikingly supported by measurements of Wood. [See also Abstract 1455 (1930).] AUTHOR.

3428. Absorption of Resonance Radiation in Mercury Vapour. A. R. Thomas. *Phys. Rev.* 35. *pp.* 1253–1260, *May* 15, 1930.

The theories of absorption in mercury vapour of mercury resonance light of wave-length 2536·7 Å. as formulated by Malinowski [see Abstract 1523 (1914)] and H. A. Wilson [see Abstract 1614 (1928)] are briefly reviewed. It is well established that the absorption coefficient for resonance radiation increases as the number of absorbing atoms decreases. This is probably due to a Doppler effect in the radiating vapour. To diminish the influence of the Doppler effect a jet of mercury vapour was used, and the resonance radiation coming from it was investigated. A series of measurements of the absorption coefficient of this light is given. The maximum atomic absorption coefficient observed is $10{\cdot}22 \times 10^{-13}$, nine times as large as any previously observed. It is shown that Malinowski's assumptions are not in accord with the observed effects. AUTHOR.

3429. Optical Excitation Functions of Mercury Lines. W. Schaffernicht. *Zeits. f. Physik,* 62. 1–2. *pp.* 106–142, 1930.

The variations in intensity of some 70 mercury lines emitted by electronic bombardment of mercury vapour were determined as functions of the electron velocity, keeping the electron current and mercury-vapour density constant. It was established that for all lines originating in the same level the optical excitation function (line intensity against electron velocity in volts) was the same. For the arc lines, two principal types of excitation function were obtained characteristic of the triplet and singlet lines respectively. The former gave a single sharp maximum situated a few volts (about 2) above the excitation voltage, the latter a single but much broader maximum situated well above the excitation voltage (about 20 volts higher). The excitation functions of intercombination lines were determined by the triplet or singlet character of the initial state. A number of lines gave excitation functions showing both the triplet and singlet peak. The occurrence of double peaks is explained as due to the two ways in which the initial excited state can be reached (*a*) by direct excitation in an electron collision, (*b*) by emission of radiation from a state of higher excitation. A number of measurements of excitation functions of spark lines are also included. W. S. S.

3430. Absorption of the Resonance Line in Mercury Vapour Mixed with other Gases. (Miss) E. A. Neumann. *Zeits. f. Physik,* 62. 5–6. *pp.* 368–393, 1930.

Describes an investigation in which the broadening of the mercury resonance line when various gases were added to the absorbing mercury vapour was measured by means of a photoelectric cell. Light from a resonance lamp was passed through a layer of mercury vapour, the density of which was kept constant. The curves showing the relation between a number of collisions and absorption coincided within the limits of the experimental error for air and argon, but not for helium and hydrogen. An endeavour was made to obtain coincidence between the curves by considering the possible effects of other physical properties of the gases; this, however, was not possible; though the molecular weights (either directly or through the resulting differences in the mean molecular velocities) and differences in the field properties of the disturbing molecules seem to be involved. It appears from the results obtained that in forced quantum changes only the lines corresponding to these changes are broadened, and that the effective sectional area of hydrogen involved in the broadening is of the order of magnitude of the area given by the kinetic theory of gases; the large extinction probability for the mercury resonance line in the case of hydrogen has no perceptible influence on the broadening effect due to this gas. The five fine structure levels of the 2^3P_1 state may be involved in the broadening. H. N. A.

3431. Light Scattering in Liquids. R. M. Langer and W. F. Meggers. *Bureau of Standards, J. of Research,* 4. *pp.* 711–735, *May,* 1930.

The theory of light scattering is discussed with special reference to the comparison between coherent and incoherent scattering, the variation of intensity with frequency of the exciting light, the nature of frequency shifts and the location of energy levels. An experimental arrangement for investigating the spectra of the mercury arc scattered by liquids is described in which an arc is used operated in a quartz capillary immersed in water at atmospheric pressure. Numerical data are given for benzene, toluene, chloroform and carbon tetrachloride to one place of decimals in cm.$^{-1}$. Comparison of the results with the available infra-red data shows no simple direct correspondence. A. C. M.

3432. Analysis of Spectrum of HgII. W. M. Hicks. *Phil. Mag.* 9. *pp.* 673–740, *May,* 1930. *Supplement.*

The first part of the paper contains a very detailed discussion of the various series and combinations of this spectrum as deduced from the measurements of various observers. The second part is concerned with a discussion of certain allocations of Paschen, particularly with regard to his lowest p_1 term. F. S.

3433. Intensity and Polarisation of the Coherent and Incoherent Radiation Scattered by Diatomic Molecules. C. Manneback. *Zeits. f. Physik,* 62. 3–4. *pp.* 224–252, 1930.

These calculations of the scattering moment of the molecule are based on the Kramers-Heisenberg dispersion formula. The matrix components of the electrical moment of the non-irradiated molecule are first deduced using the known eigenfunctions of the diatomic molecule. These are then inserted into the dispersion formula and the matrix components yielding the scattered radiation are evaluated, making certain approximations. It is assumed that the electron frequencies of the molecule and the incident frequency are large compared with the oscillation frequency of the molecule. Formulæ are given for the intensity and polarisation of the unmodified (Rayleigh) and modified (Raman) lines. It appears that when the rotation fine structure of the Rayleigh line is unresolvable, the c. of g. of the line is displaced slightly towards the red, an effect which may explain the observation of Cabannes and Daure that butane vapour gives a red displacement of the " unmodified " lines of 0·01 Å. W. S. S.

3434. Raman Effect with Diatomic Molecules. E. Segrè. *Accad. Lincei, Atti,* 11. *pp.* 825–831, *May* 4, 1930.

Photographs of the Raman effect in the case of O_2 were obtained by Rasetti [see Abstract 3145 (1930)] in favourable circumstances, and these photographs have been photometrically examined by the author. The formula of the quantistic mechanics for the intensity of the Raman rays in the case of the molecule O_2 is developed. A comparison between the results of the calculations and the photometric measurements shows satisfactory concordance. J. J. S.

3435. Raman Spectrum of some Organic Halogen Compounds. S. Bhagavantam and S. Venkateswaran. *Roy. Soc., Proc.* 127. *pp.* 360–373, *May* 7, 1930.

Measurements of the Raman spectra of fifteen halogen derivates of aliphatic and two of aromatic hydrocarbons are reported in tabular form. Arguments are advanced in favour of the view that the Raman lines observed are in most cases fundamental vibrations of the molecule and not combinational or overtones. The prominent frequencies of the aliphatic chlorine compounds range about the mean values $\Delta\gamma = 750$, 660, 320, 250 wave numbers, against $\Delta\gamma = 660$, 550, 230, 160 wave numbers for the bromine compounds. The data suggest that the lines $\Delta\gamma$ 750 and $\Delta\gamma$ 660 can be ascribed to vibrations in the C–Cl and C–Br bonds respectively. A possible explanation of the diffuseness of lines shifted by these frequencies as due to an unresolved structure arising from the chlorine or bromine isotopes is put forward tentatively. W. S. S.

3436. Raman Effect and Molecular Constitution. Part I. B. Trumpy. *Zeits. f. Physik*, 62. 11–12. *pp*. 806–823, 1930.

The Raman effect exhibited by the propyl and butyl alcohols is investigated experimentally. The measured frequencies are compared with deductions from the oscillation theory of the effect, and a number of characteristic external and internal groups of oscillations are identified. Moreover, these frequencies are in good agreement with those deduced from the chemical constitutional formulæ of the alcohols. J. S. G. T.

3437. Dispersion Formula and Raman Effect for the Symmetrical Top. M. Muskat. *Phys. Rev.* 35. *pp*. 1262–1269, *May* 15, 1930.

Schrödinger's theory of dispersion [see Abstract 55 (1927)] is applied to the symmetrical top. The dipole of the top is assumed to be the axis of symmetry, and the wave-length of the incident light to be large as compared with the dimensions of the top. An explicit expression is derived for the index of refraction of a gas composed of symmetrical tops as a function of the frequency of the incident light. As the perturbed eigenfunction is a linear function of only 3 unperturbed eigenfunctions, the dispersion formula, for a given state, consists of only 2 terms. The moments for the Raman effect transitions for the symmetrical top are also computed. Simple closed expressions are obtained, again because of the simplicity of the perturbed eigenfunctions. The polarisation of the Raman variations is computed, with the result that the unshifted lines are unpolarised, whereas for the shifted lines: $|m_z|^2/|m_x|^2 = 4/3$. **Errata,** *ibid.* 36. p. 363, July 15, 1930. AUTHOR.

3438. Raman Effect in Water. Parts I and II. E. H. L. Meyer and I. Port. *Phys. Zeits.* 31. *pp*. 509–511, *May* 15, 1930.

In Part I is described an investigation of the relative intensities of the Raman lines scattered in water at different temperatures. In the visible region it is shown that the line 4696 Å. excited by 4047 Å. is considerably stronger at 98° C. relative to the corresponding line 4171 Å. scattered by 3650 Å. than it is at 2° C. The matter is also investigated in the ultraviolet; at 11·5° C. the three Raman bands at 3375, 3306 and 2918 Å. have the same intensity, while at 55° C. the band at 3306 Å. is about 20 % stronger than the other two. In Part II is described an investigation into the structure of the Raman water bands, when it is shown that they are single, not double, bands. The line 3507 Å. was photometrically investigated at 11·5° C., 55° C. and 100° C., when the top of the photometer curve is found to become blunter as the temperature rises. A. C. M.

3439. Raman Spectra of Crystalline and Dissolved Nitrates. W. Gerlach. *Ann. d. Physik*, 5. 2. *pp*. 196–204, *May* 27, 1930.

The inactive frequency of the NO_3 group (about 1050 cm.$^{-1}$) is measured in the spectra scattered by various crystalline nitrates. It is found that the exact value varies with the metal ion, and that in certain cases—notably lithium and sodium—the value is markedly greater in the crystalline state. Solutions of sodium and lithium nitrates are also examined in varying concentrations; it is found that the frequency increases with increasing concentration. A. C. M.

3440. Raman Effect in HCl Gas. R. W. Wood and G. H. Dieke. *Phys. Rev.* 35. *pp.* 1355–1359, *June* 1, 1930.

Improvements in the experimental conditions made it possible to get much better pictures of the Raman effect in HCl gas than before. The results agree perfectly with predictions from the dispersion theory. AUTHORS.

3441. Zeeman Effect of the Argon Spark Spectrum (AII). Part II. C. J. Bakker and T. L. de Bruin. *Zeits. f. Physik*, 62. 1–2. *pp.* 32–42, 1930.

The new photographs of the spectrum are an improvement on those on which Part I [see Abstracts 489 and 830 (1929)] was based: the weak lines can be measured more accurately, and the two polarised states can be separated better. A table gives the newly classified lines and lines which are better resolved in the new plates; Rosenthal's wave-lengths are given, de Bruin's term combinations, the Zeeman effect calculated from Landé's *g*-formula, and that observed. The terms of the 4*s* electron have all normal *g*-values, unlike those of the 4*p* electron. Under the terms which converge to the limits ^1D and ^1S *g*-values occur which differ from those calculated from Landé's formula. Tables give the observed and calculated *g*-values for different cases. The *g* sum law is found to hold for certain terms in addition to those noted in Part I. This is true even when anomalous *g*-values occur. Certain asymmetrical Zeeman effects observed are explained by means of the partial Paschen-Back effect. H. N. A.

3442. Some Leading Features of the Stark Effect. J. S. Foster. *Frank. Inst., J.* 209. *pp.* 585–624, *May*, 1930.

This is a *résumé* of present knowledge concerning the effect. After an historical introduction, the various light sources and some suitable spectrographs are described. An interpretation of the spectra of H and He is given, while the effect in parhelium is considered in detail. Later on in the paper the effect in orthohelium and the use of electric and magnetic fields both crossed and in parallel are discussed. A comparison of normal Stark and Zeeman effects is made and the effect in other complex spectra described. F. S.

3443. Hydrogen Atom in the Stark Effect. F. G. Slack. *Phys. Rev.* 35. *pp.* 1170–1176, *May* 15, 1930.

Characteristics of the hydrogen atom wave function, which show the statistical distribution of electronic charge with respect to the nucleus and electric field, are computed for the first five quantum states. The results are tabulated and are represented graphically for one state as an example. The average coordinates of the electronic charge are also computed and included in the tabulation. AUTHOR.

3444. Third Order Stark Effect in Hydrogen Series Lines Hβ and Hγ. R. Gebauer and H. R. v. Traubenberg. *Zeits. f. Physik*, 62. 5–6. *pp.* 289–299, 1930.

Hydrogen canal rays were acted on by fields perpendicular to the direction of the rays, with intensities up to 947,600 volts/cm., and the Stark effect for the Balmer series lines Hβ and Hγ was observed and measured. It became possible to compare these experimental results with the values calculated by Schrödinger's theory. The accuracy of the measurements was so high that the comparison can be extended to the third degree term of the equation (third order Stark effect). It appears that in the case of fields which with Hγ come very near to the limit of existence of the excited atom (about 1 million volts/cm.) there is excellent agreement with Schrödinger's theory. Very small systematic deviations for the highest fields point, in the case of Hγ, to the influence of a term of the fourth order. H. N. A.

3445. Effect of Nuclear Spin on Optical Spectra. Parts II and III. J. Hargreaves. *Roy. Soc., Proc.* 127. *pp.* 141–154, *April* 1, *and pp.* 407–416, *May* 7, 1930.

In Part II the case of one electron in a central field is considered, and a general method of solving the problem is developed, and applied when $i_n = 1, 1\frac{1}{2}, 4\frac{1}{2}$, where i_n is the number of quanta in the nuclear spin. The last case applies to bismuth, the hyperfine structure of which is known to be due to a spin of $4\frac{1}{2}$ quanta. It has been found possible to calculate the intensities of the components of the lines $p_{3/2} \rightarrow s_{1/2}$, and $p_{1/2} \rightarrow s_{1/2}$, and the results are in fair agreement with the experimental values. In Part III the interaction energy of the nuclear and electron spins is calculated, in addition to the energy increments already calculated in Parts I and II, with the result that the multiple energy levels can now be correctly described. The work is carried out for the cases $i_n = \frac{1}{2}, 1\frac{1}{2}, 1, 4\frac{1}{2}$, where i_n is the number of quanta of nuclear spin. It is found that in the case of the $p_{1/2}$ levels the interaction energy of the two spins is equal to that of the nuclear spin and orbital momentum, while for the $p_{3/2}$ level the ratio is $-\frac{1}{5}$. The energy levels of the S terms are correctly given in Parts I and II. Assuming that Jackson was only able to observe the multiplet structure of the cæsium lines due to the separation of the S level, the theory agrees quite well with his observations. The results for the hyperfine structure of the Zeeman lines agree with Back and Goudsmit's observations for bismuth. This confirms the validity of the empirical equations in Parts I and II. [For Part I see Abstract 202 (1930).] H. N. A.

3446. Hyperfine Structure in Neutral Manganese, MnI. H. E. White and R. Ritschl. *Phys. Rev.* 35. *pp.* 1146–1160, *May* 15, 1930.

The hyperfine structure patterns of lines in the spectra of MnI are photographed by means of Fabry-Perot étalons, a specially designed tube being used as light source. Some terms are computed, and vector diagrams for multiplet terms studied. The hyperfine structure formula of Goudsmit and Bacher [see Abstract 1876 (1930)] for the interaction between an *s*-electron spin and nuclear spin is extended to include the spins and *l*-values of all the valence electrons. From the derived general formula and the observed hyperfine structure term separations, coupling constants associated with each electron are computed. C. B. A.

3447. Predissociation of Diatomic Molecules from High Rotational States. D. S. Villars and E. U. Condon. *Phys. Rev.* 35. *pp.* 1028–1032, *May* 1, 1930.

Instability of molecules in high rotational states, as observed especially in HgH and AlH, is a phenomenon whose quantum-mechanical explanation is closely analogous to that of the radioactive disintegration of atomic nuclei. The heat of dissociation of AlH from its normal state is estimated to be 3·07 volts. AUTHORS

3448. Significance of Predissociation Phenomena in Band Spectra. G. Stenvinkel. *Zeits. f. Physik*, 62. 3–4. *pp.* 201–207, 1930.

It is shown how radiationless transitions in excited molecules, leading to dissociation, may cause the normal intensity distribution in band series to be modified; in the extreme case, the intensity may drop sharply to zero at a certain critical value. It appears that raising the pressure of the luminous gas should tend to minimise this effect. The influence of pressure on the $^1\Pi \rightarrow {}^1\Sigma$ bands of AlH has been studied by Bengtsson, who found that at low pressures the series broke off sharply, but, as the pressure increased, more and more lines were brought up. This is in agreement with the argument put forward by the author. W. S. S.

3449. Quantum-Mechanical Theory of Radioactivity and Dissociation by Rotation of Diatomic Molecules. O. K. Rice. *Phys. Rev.* 35. *pp.* 1538–1550, *June* 15, 1930.

In the recent theory of radioactive decay, and also, as is shown, in the theory of dissociation of a diatomic molecule by the acquisition of rotational energy, there occurs a potential energy curve the shape of which is such that, going from left to right, the potential energy is first very high, then falls to a minimum and increases to a maximum, and again falls off to an asymptotic value. The problems connected with such a curve are of two types. In the first case, given a particle in the region near the minimum, in an energy level which lies below the maximum, we may wish to find the chance that it appears by a quantum-mechanical process in the region on the other side of the maximum. In the second case, we wish to find how the " discrete states " in the neighbourhood of the minimum are " broadened " by the continuum on the other side of the maximum. To solve these problems the stationary eigenfunctions have to be found. By means of them the width and shape of the " broadened discrete levels " are found immediately. These eigenfunctions are then used to set up a wave packet, or rather, we show how nature may set up a wave packet, which enables us to solve the first of the problems mentioned. The result justifies the use of complex eigenvalues for the solution of the problem. [See also Abstracts 532 and 2212 (1929) and following Abstract]. AUTHOR.

3450. Perturbations in Molecules and the Theory of Predissociation and Diffuse Spectra. Part II. O. K. Rice. *Phys. Rev.* 35. *pp.* 1551–1558, *June* 15, 1930.

Further consideration is given to the problems which arise when the continuum of one electronic state of a diatomic molecule occurs in the same range as the discrete states of another electronic state. In finding the electronic states and the potential curves which go with them certain approximations must be made; a better approximation can then be obtained by quantum-mechanical perturbation theory. The discrete states are broadened, and this will appear, in as much as spectral lines involving these states are broadened. In this paper the shape of the broadened spectral lines is found, certain properties of the perturbation matrix are considered, and a wave packet is set up, or rather one such as would be set up by nature is used, to give all the details of a radiationless transition from a discrete state to the overlying continuum. [See also Abstract 2953 (1929) and preceding Abstract.] AUTHOR.

3451. Classification of Types of Combination of Diatomic Molecules. H. Lessheim and R. Samuel. *Zeits. f. Physik*, 62. 3–4. *pp.* 208–223, 1930.

The classification is based on certain features of the potential energy—nuclear separation curves of the two lowest electron terms of the molecule.

It can be deduced whether the band system corresponding to transitions between these two electron terms shows shading off towards the red or towards the violet. It is shown that atom molecules which remain atom molecules in the first excited electron state give violet shading of this band system if the total electron number is odd and the combination is effectively Coulomb interaction. Red shading is obtained if the total electron number is even or if the total electron number is odd, but the combination is controlled by the interchange forces. In the case when one of the electron states is an atom compound, the other an ion compound, no definite statement about the shading can be made. W. S. S.

3452. Spontaneous Disintegration of Diatomic Molecules. R. de L. Kronig. *Zeits. f. Physik*, 62. 5–6. *pp.* 300–310, 1930.

Discusses the theory of spontaneous disintegration, as it has been studied by Hulthén for HgH, where it is due to increase in the energy of rotation in the normal state of the molecule, by Henri, who discovered the phenomenon of predissociation in the spectrum of sulphur vapour, and by other authors. A general theory covering the whole subject is put forward, and it is shown that a number of the predictions of the theory, which have not previously been confirmed, agree in a satisfactory manner with the results of previous experimental work. H. N. A.

3453. Extension of Houston's and Slater's Multiplet Relations. S. Goudsmit. *Phys. Rev.* 35. *pp.* 1325–1336, *June* 1, 1930.

Expressions giving the change in the positions of the energy levels with change in electron coupling are derived. The change in *g*-values is discussed also. The method of derivation is a short-cut of the rigorous detailed method and therefore simpler. One knows the form of the equations of which the desired energies must be roots. The coefficients of these equations are determined by the known results for extreme couplings. This method does not always give all coefficients, but even in complicated cases useful relations between the energy levels are found. [See also Abstracts 2483 (1929) and 1452 (1930).] AUTHOR.

3454. Resonance Separations in Configurations of Type p^5s and d^9s. O. Laporte and D. R. Inglis. *Phys. Rev.* 35. *pp.* 1337–1341, *June* 1, 1930.

Considerations concerning the invariance of the configurations p^5 and d^9 with changing coupling lead to application of Houston's formula [see Abstract 2483 (1929)] to the cases p^5s and d^9s with negative A and X values. The expressions thus obtained are tested on the separations and *g*-values of numerous spectra. The agreement is satisfactory. AUTHORS.

3455. Singlet-Triplet Interval Ratios for sp, sd, sf, p^5s and d^9s Configurations. E. U. Condon and G. H. Shortley. *Phys. Rev.* 35. *pp.* 1342–1346, *June* 1, 1930.

A systematic comparison of the known data on the singlets and triplets arising from sp, sd, sf, p^5s and d^9s configurations with the theory of Houston [see Abstract 2483 (1929)] shows that the theory gives a good account of the deviations from the Landé interval rule which accompany departure from the Russell-Saunders coupling. There are numerous significant discrepancies, however. Writing ${}^1L_l$ and ${}^3L_{l+1}$, ${}^3L_l$, ${}^3L_{l-1}$ with L = P, D, F, when $l = 1, 2, 3$, for the term values, we plot as abscissa $({}^3L_{l-1} - {}^3L_{l+1})/|{}^3L_l - {}^1L_l|$ and $({}^3L_{l-1} - {}^3L_l)/({}^3L_l - {}^3L_{l+1})$ as ordinate if $({}^3L_l - {}^1L_l)$ is positive, otherwise the reciprocal of this quantity.

Houston's equations (12) give functional relations between these interval ratios which are compared with the experimental values. AUTHORS

3456. Vibrational Quantum Analysis of Blue-Green Bands of Magnesium Oxide. P. N. Ghosh, P. C. Mahanti and B. C. Mukkerjee. *Phys. Rev.* 35. *pp.* 1491–1494, *June* 15, 1930.

The paper deals with the assignment of the vibration quantum numbers of the violet degrading system of the magnesium oxide bands. The frequencies of vibration for infinitesimal amplitude are found to be 716 cm.$^{-1}$ and 751 cm.$^{-1}$ for the upper (initial) and lower (final) states respectively. The heat of dissociation as calculated from the extrapolation of the $\omega^{n}:n$ curve is nearly 5·8 volts. AUTHORS.

3457. Statistical Calculation of the Spectrum of an Ionised Atom. E. Segrè. *Accad. Lincei, Atti*, 11. *pp.* 670–673, *April* 6, 1930.

A discussion of how and to what extent by methods of quantum statistics alone it is possible to construct a spectrum of the ionised atom. The only data required are the atomic number and the degree of ionisation of the atom. As result there are obtained the scheme of the levels of energy, the separation of a doublet and Rydberg's corrections. The calculations are only approximate, but there is satisfactory agreement between observation and calculation. Hitherto the method has been applied only to the case of neutral atoms, but recently Fermi has succeeded in establishing the potential in the case of ionised atoms also. J. J. S.

3458. Number of Dispersion Electrons in Cæsium. T. Mutô. *Phys. Math. Soc., Japan, Proc.* 12. *pp.* 93–100, *May*, 1930. *In English.*

An estimation of the number of dispersion electrons and transition probabilities for each line of the principal series of cæsium, got by assuming that each electron moves in a central non-Coulomb field of force. The field is computed by using the observed term values as eigenvalues of the wave equation. The values are given for the transitions $n_2 - 6_1$ from $n = 6$ to $n = 11$, and are in agreement with experiment. A. C. M.

3459. Electromagnetic Field of Light Quanta. F. J. v. Wisniewski. *Zeits. f. Physik*, 62. 5–6. *pp.* 394–400, 1930.

Continues the previous investigations of the author, in which he obtained a differential equation which fully described the behaviour of a monochromatic light wave, provided that each light quantum was regarded as an electrical dipole. It is now shown that the term $1/c \times \partial/\partial t$ in Maxwell's equations can be regarded as following from the reciprocal action between the light quanta. H. N. A.

3460. Magnetophotophoresis and Electrophotophoresis. F. Ehrenhaft. *Phys. Zeits.* 31. *pp.* 478–485, *May* 15, 1930.

A review of the researches on this subject. The longitudinal electro- and magnetophotophoresis may perhaps be explained by supposing that the transition conductivity changed by the external field over the whole body increases or diminishes and correspondingly the photophoresis increases or diminishes. [See also Abstract 2207 (1930).] J. J. S.

3461. Soft X-Rays of Manganese. F. C. Chalklin. *Phil. Mag.* 9. *pp.* 847–857, *May*, 1930. *Supplement.*

The critical potentials of manganese were determined by two methods, both variations of the photoelectric method. In one the stream of bombarding electrons fell partly on a manganese and partly on a carbon antikathode. The two X-ray beams were then passed to two photoelectric cells and the ratio of the photoelectric currents measured for different bombarding voltages. Discontinuities in this ratio gave the critical potentials of carbon (known) and manganese. The second method did not involve the use of a carbon target. In the critical potentials obtained, two series of the form $X - b/n^2$ were identified, (1) $X = 197 \cdot 3$ volts, $n = 4$ to 12, (2) $X = 288 \cdot 3$ volts, $n = 4$ to 13, the constant b having the same value, 2357 V, as found for similar series of Co, Ni and Cu. These series account for nearly all the critical potentials observed below 280 volts; above this voltage an extended series scheme would be necessary to include the discontinuities found. W. S. S.

3462. Explanation of Certain X-Ray Tube Phenomena. A. Ianitzky. *J. de Physique et le Radium*, 1. *pp.* 153–162, *May*, 1930.

The experimental observations show that the discharge in an ionisation tube ceases if the anode is strongly degassed. It appears that the current, in a tube with degassed metal anode touching a non-degassed piece of the same metal, follows the direction of displacement of gas. It is shown that in a high vacuum tube gas leaves the anode under the influence of a high voltage. The hypothesis is advanced that the gas dissolved in the metal is in a state of dissociation into positive and negative ions. Using this hypothesis the author explains various phenomena observed in X-ray tubes. A. B. W.

3463. Calibration of the "Fingerhut" Ionisation Chamber. L. S. Taylor and G. Singer. *Bureau of Standards, J. of Research*, 4. *pp.* 631–644, *May*, 1930.

The use of the " thimble " ionisation chamber (*Fingerhutkammer*) has in the past been the only method for comparing the primary X-ray standards of different laboratories, hence the precise calibration of two thimble chambers is discussed in this paper. Five principal factors determine the accuracy of such a calibration, and it is shown that the errors are all, in general, in the same direction. It is shown that the X-ray beam must have a uniform section sufficient to cover the thimble chamber and yet not be so diaphragmed that off-focus radiation may impair the readings of the standard chamber. The chamber must be carefully aligned in the beam experimentally and not merely centred on the basis of its geometrical shape, since the distribution of measured ionisation is found to vary considerably over the length of the chamber. In the investigation of the standard ionisation chamber [see Abstracts 2844 (1929) and 1476 (1930)] the special conditions affecting the applicability of the inverse square law were described. The same general conditions were found to hold true for the thimble chamber, indicating the necessity of a careful analysis of the diaphragm system before proceeding with the calibration. The " wall effect " of two thimble chambers was studied, and the strong dependence upon quality of radiation indicated that any intercomparison by means of such a chamber will be valid only under identical conditions of voltage, filtration and wave form of generator. AUTHORS.

3464. X-Ray Intensity Measurements. J. Schechtmann. *Ann. d. Physik*, 5. 2. *pp.* 153–195, *May* 27, 1930.

An investigation into the influence of various factors on the intensity measurement of X-rays by means of the ionisation chamber method. Such factors are (*a*) difference in cross-section and in potential of the working electrode and the guard-ring electrodes, (*b*) the potentials of the end-surfaces and their distances from the working-electrode, and (*c*) the various diaphragms and the position of the chamber with regard to the axis of the X-ray tube. A. C. M.

3465. Fine Structure of Magnetic Spectra of X-Rays. S. Rosenblum. *Comptes Rendus.* 190. *pp.* 1124–1127, *May* 12, 1930.

The earlier measurements have been extended and their accuracy improved. [See Abstract 3359 (1929).] F. J. W.

3466. Dispersion of X-Rays. E. Nähring. *Phys. Zeits.* 31. *pp.* 401–418, *May* 1, 1930.

The paper is a collection of available data on the question of the refractive index of X-rays in various materials. After an historical introduction the methods of determining the refractive index are described, the chief being the deviations from Bragg's law of reflection and total reflection. The experimental arrangements employed by various investigators are described. The theory of X-ray dispersion and experimental results are next discussed. The paper appears to contain nothing new, but is a good summary of present experimental and theoretical work on the subject. A fairly complete Bibliography is included. W. V. M.

3467. X-Ray Interference and Atomic Dimensions. P. Debye. *Phys. Zeits.* 31. *pp.* 419–428, *May* 1, 1930.

The angular distribution of scattered X-ray intensity obtained by passing an X-ray beam through a polyatomic gas, when computed on the assumption that the scattering is localised at the centres of the atoms, gives a curve with pronounced maxima and minima. Experimental determinations of the distribution show marked deviations from this theory, the falling off in intensity with increase of angle being much more rapid and resulting in some cases in the smoothing out of the maxima. It is shown that, if the theory is modified by treating the atoms as extended scattering domains, curves of the observed type are obtained. The electron distribution about the nucleus is first assumed to be given by a Gauss error curve, but the theory is improved by using the electron distribution derived by Thomas and Fermi. The case of CCl_4 is dealt with in detail, and the deduction is made by comparing experimental and computed distributions that the distance apart of the chlorine atoms equals 2·99 Å. Other cases discussed are N_2, O_2, Cl_2, CO_2, CS_2, S_2 and $C_2H_2Cl_2$, differences in the scattering distributions of the two isomers of $C_2H_2Cl_2$ (established experimentally) being explained. W. S. S.

3468. Possible Effects of Nuclear Spin on X-Ray Terms. G. Breit. *Phys. Rev.* 35. *pp.* 1447–1451, *June* 15, 1930.

It is shown that magnetic moments of nuclei are likely to cause small but presumably measurable separations of X-ray terms. A nucleus having a spin of 9/2 (in units of $h/2\pi$) and a magnetic moment 9/2 in protonic units should cause the K terms of the heaviest elements to split into two components separated by about 22 volts. Such separations require for their detection a resolving power of 4200. For lighter elements the effect is relatively smaller. The same nuclear spin and magnetic moment would cause a separation of only 0·9 volt in Mo which would require for its detection a resolving power of $1 \cdot 9 \times 10^4$. The calculations are made using Dirac's equation for a single electron without approximations. The effect of electrons in another shell, however, is neglected.

It is estimated to be very small for a single K electron. If the observation of hyperfine structures in the K series of the heavier elements proves feasible, it should offer a simple means of determining magnetic moments of nuclei having a known spin. AUTHOR.

3469. Reflection of X-Rays from Artificially Prepared Bodies of Laminated Structure. W. Deubner. *Ann. d. Physik,* 5. 2. *pp.* 261–280, *May* 27, 1930.

Solids with a laminated structure have been prepared, *e.g.,* by the alternate deposition of thin layers of gold and silver upon one another, and examined by the rotating crystal method. The only interference lines observed were those corresponding with the lattices of the metals. There was no indication of any interference which might have been due to the agency of the thin metallic layers. F. J. W.

3470. X-Ray Diffraction in Benzene, Cyclohexane and their Homologues. S. Tanaka and A. Tsuji. *Kyoto Coll. Sci., Mem.* 13. *pp.* 169–173, *March,* 1930. *In English.*

In the present experiment, the authors used two narrow, long slits to limit the X-rays instead of circular ones, and obtained finer photographs of the diffraction patterns. Fourteen substances, nine of which had been already studied in the former experiment, were investigated, and the new results are discussed. A second maximum was found in the diffraction band of benzene, and the diameter and the thickness of the benzene molecule, which was assumed to have a flat disc form, was determined. The substitution group CH_3 changes the molecular form as a group or a branch in the benzene homologues. The diffraction bands of cyclohexane and its homologues all gave a single sharp maximum which suggested that the form of the molecules was spherical. The substitution group CH_3 seems to increase their diameter uniformly. AUTHORS.

3471. X-Ray Diffraction in Liquid Hexamethylbenzene. P. Krishnamurti. *Indian Journ. Phys.* 4. *pp.* 449–455, *April* 30, 1930.

A comparison of powdered hexamethylbenzene studied by Lonsdale [see Abstract 2676 (1929)] and the liquid substance. The melting point is 164° C. The two strongest rings (due to [001] and [100] planes) of the solid persist in the liquid. The spacings are 8·2 and 4·2 Å. in the liquid and 7·7 and 3·7 Å. in the powder. The spacings are thus wider in the liquid, and the rings are more diffused; the inner ring is stronger than the outer, and there is much scattering within the inner rings. The 4·2 Å. spacing probably indicates the thickness of the molecule, the 8·2 periodicity in a plane of the benzene ring. The density deduced is 0·95 at 175° C. According to Stewart [see Abstract 218 (1930)], the inner of the two rings of benzene should mark the thickness of the molecule. The author takes the opposite view from his study of many benzene derivatives, comprising ortho and meta derivatives and mesitylene. H. B.

3472. Liquid Structure and X-Ray Diffraction in Liquids. K. Banerjee. *Indian Journ. Phys.* 4. *pp.* 541–556, *June* 30, 1930.

Raman and Ramanathan applied the Boltzmann principle to analyse liquid structure and thereby to explain the diffraction effects in liquids. The method is modified so as to take into account the nature of the field of force surrounding the molecules. The liquid structure is a degeneration of the crystal structure brought about by thermal agitations, and hence some of the intense crystal diffraction lines give rise to liquid diffraction maxima, while others are quenched out. Simple cases of Na, K, A and Hg are fully discussed and found to agree with the experimental results. The intensity distribution for rays diffracted by mercury is calculated according to theory and is found to agree with the photographs given by Prins. AUTHOR.

3473. Effect of Electric Field on the X-Ray Diffraction Pattern of a Liquid. R. L. McFarlan. *Phys. Rev.* 35. *pp.* 1469–1475, *June* 15, 1930.

An investigation is made of the effect produced on the X-ray liquid diffraction pattern by an electric field so designed as to give the Kerr effect for the liquid under examination. The liquid diffraction pattern is obtained by replacing the crystal of a Bragg spectrometer with a cell containing the liquid. The electric field is approximately normal to the X-ray beam. Nitrobenzene is found to show an increase in peak intensity, on applying the field, ranging from four to seven times the probable error of observation, while benzene shows no observable effect. For the type of field used, nitrobenzene shows a large Kerr effect, while benzene shows it only slightly. Theoretical considerations indicate that this effect cannot be due to molecular orientation alone, but that an increase in the regularity of the spatial distribution of molecular scattering centres must occur. AUTHOR.

3474. Reflection of Kα Line of Carbon from a Glass Mirror. J. Thibaud. *Phys. Rev.* 35. *pp.* 1452–1455, *June* 15, 1930.

The author recalls previous experiments which he tried [see Abstract 3047 (1928)] in order to determine the limiting angle of total reflection from a glass grating for a set of radiations between 20 and 65 Å., making a slight correction to a recent work of E. Dershem [see Abstract 1077 (1930)] on the reflection of the Kα line of carbon. In the case of glass with $\lambda = 44 \cdot 9$ Å., if we take into account the discontinuities of absorption in the dispersive medium, the Kallman-Mark dispersion formula leads us to a result ($\delta = 1 - n = 5 \cdot 73 \times 10^{-3}$) of the same order as the Drude-Lorentz simplified formula. The reflected intensity from the mirror is calculated from the angle of incidence, account being taken of the absorption. The result is then compared with the experimental curve given by Dershem for the Kα line of carbon, and shows that it is possible to determine the critical angle of total reflection from glass ($\theta_m = 6°12'$) and the refractive index ($\delta = 1 - n = 5 \cdot 84 \times 10^{-3}$). AUTHOR.

3475. Molybdenum L-Series Wave-lengths by Ruled Gratings. J. M. Cork. *Phys. Rev.* 35. *pp.* 1456–1462, *June* 15, 1930.

With plane-ruled gratings having 30,000 lines and 14,400 lines per in. and grating to photographic plate distances up to 1 m. in length *in vacuo*, about 160 plates were taken of the Mo L-series lines. The wave-lengths for $L\alpha_1$ and $L\beta_1$, as given by Siegbahn using a gypsum crystal, are 5·3943 Å. and 5·1658 Å. If a calcite crystal were employed and approximate correction made for refraction, wave-lengths 5·3960 Å. and 5·1674 Å. should be expected, whereas the average of the ruled grating measurements gave 5·4116 Å. and 5·1832 Å. A comparison of the two values leads to an apparent value of the electronic charge $4 \cdot 8162 \times 10^{-10}$ e.s.u., being slightly higher than Bearden's value using Cu K lines [see Abstract 3580 (1929)]. The possibility of the variation being due to anomalous variation in the refractive index of the crystal is discussed. AUTHOR.

3476. Independence of X-Ray Absorption on Temperature. J. A. Bearden. *Phys. Rev.* 35. *pp.* 1463–1468, *June* 15, 1930.

If the absorption coefficient of X-rays is dependent upon the temperature of the absorber, it is pointed out that the effect can be made easily measurable by increasing the thickness of the absorber. Using this method in which the thickness was made very great, measurements have been made on Al, Cu, Fe, Ni, Ag and Pb. Heterogeneous X-rays were used with voltages from 30 to 80 kV, also the monochromatic X-ray lines $K\alpha_{1,2}$ of silver and copper were used. All measurements showed no effect of temperature on the absorption coefficients within the probable error involved in the thermal expansion coefficients. It is also pointed out that the effect of temperature on the absorption of X-rays and γ-rays as found by previous investigators [see Abstracts 708 (1927) and 2520 (1929)] was probably due to an error in the determinations of the linear absorption coefficient. When their results are corrected, using the absorption coefficient of the beam transmitted by the absorber, the results are in agreement with the present experiments. AUTHOR.

3477. Resolving Power of Calcite for X-Rays and Natural Widths of Molybdenum Kα Doublet. S. K. Allison and J. H. Williams. *Phys. Rev.* 35. *pp.* 1476–1490, *June* 15, 1930.

The half-widths at half-maximum of the rocking curves in parallel positions of the double X-ray spectrometer have been observed for the first five orders of reflection of $MoK\alpha_1$ from calcite. The calculated half-widths for a single crystal have been compared with the theoretical results of Darwin [see Abstract 1262 (1914)] and Ewald [see Abstract 1397 (1925)]. The observed values are of the same order of magnitude as the theoretical, but slightly larger (1·4 times as large in the first order). The rocking curve widths in eight anti-parallel positions for $MoK\alpha_1$ at 50 kV have been observed. Geometric corrections arising from the vertical spread of the beam have been applied. The half-width at half-maximum of $MoK\alpha_1$ was found to be 0·147 X.U. corresponding to an energy width of 3·6 V, and no significant variation was detected with voltages from 25 to 50 kV. The half-width at half-maximum of $MoK\alpha_2$ at 50 kV was observed in two positions and fround to be 0·161 X.U., the corresponding energy width being 3·9 volts. The observed difference between α_1 and α_2 is close to the experimental error and may not be real. The observed values are 2·5 times as great as the width to be expected from a classical electronic oscillator damped by its electromagnetic radiation. The computed life of the excited K state of molybdenum is $1\cdot 8 \times 10^{-16}$ sec. No evidence of fine structure of $MoK\alpha_1$ or α_2 was obtained. AUTHORS.

RADIOACTIVITY.

3478. Centrifugation of Acid (HCl) Solutions of Polonium. (Miss) C. Chamié and M. Guillot. *Comptes Rendus*, 190. *pp*. 1187–1189, *May* 19, 1930.

It was found that in a normal HCl solution, polonium treated in a centrifugal machine remained in solution to within 1/200th part; with a decinormal HCl solution there was a small precipitation, and this became considerable with a centinormal solution; with a neutral medium almost all the polonium was precipitated if the activity was fairly large, but for small activity the percentage decreased. Adding a trace of NH_4Cl increased the precipitation, but if neutralisation was effected in a solution containing 50 % of glycerine, precipitation was considerably diminished. The experiments show that the results are due to precipitation of a product of hydrolysis in a colloidal form. The results agree with the experiments of Hahn and Werner on the hydrolysis of ThC. It is shown that the phenomenon is not due to colloidal silica in the solution. Photographic impressions of groups of polonium atoms have been obtained with normal HCl solutions sufficiently activated, which give no precipitate when centrifugated; whether these groups pre-exist in the solution, or are formed in contact with the wall on which they are photographed, is as yet unknown. H. N. A.

3479. Measurements of the Ranges of α-Particles. (Miss) G. I. Harper and (Miss) E. Salaman. *Roy. Soc., Proc.* 127. *pp*. 175–185, *April* 1, 1930.

Extrapolated ranges, as defined by Henderson, have been measured for α-particles from radium C′, thorium C, thorium C′ and polonium, in air, oxygen, nitrogen, argon and hydrogen. The portion of the Bragg curve from the maximum to the end of the range was experimentally determined, the distance of the source from the ionisation chamber being varied, and the pressure kept constant during each set of observations. The results for polonium agree with those of Curie, Joliot and Onoda, and of Onoda. For argon and hydrogen the ranges agree with those calculated from Gurney's stopping powers. The relation between ranges and initial velocities is discussed. It is shown that the theory of Gaunt for the stopping power of hydrogen atoms can be extended to the case of molecular hydrogen. H. N. A.

3480. Probability Fluctuations in the Rate of Emission of α-Particles. L. F. Curtiss. *Bureau of Standards, J. of Research*, 4. *pp*. 595–599, *April*, 1930.

The deviation from a simple probability distribution of the rate of emission of α-particles from polonium has been investigated as a preliminary step to the investigation of the relation of the phenomenon of aggregate recoil to this anomalous behaviour of polonium sources. This work shows that a freshly prepared source exhibits a subnormal dispersion which after about 35 days has become normal as tested by the divergence coefficient Q_2. This is in agreement of observations by Kutzner [see Abstract 2114 (1924)]. AUTHOR.

HEAT.

3481. Theory of Heat Conduction. M. S. van Dusen. *Bureau of Standards, J. of Research,* 4. *pp.* 753–756, *June,* 1930.

A simple transformation of the general equation for heat flow is given, which does not appear to be generally known. By means of this transformation most problems in steady heat flow with conductivity depending on temperature can be derived directly from the solutions of the same problems where the conductivity is assumed constant. The paper is entirely mathematical. AUTHOR.

3482. Effective Temperature of a Warmed Room. A. F. Dufton. *Phil. Mag.* 9. *pp.* 858–861, *May,* 1930. *Supplement.*

A provisional standard of thermal comfort in a warmed room can be based on the rate of loss of heat of a sizable body at 75° F., and this will depend on the temperature of the air and the walls which will in general be different. A special black body and a thermostatic device to maintain it at 75° F., with measurement of the power supplied, are described. Calibration in terms of effective temperature was obtained by recording the heat loss in still air in a room with air and walls at the same temperature. A special katathermometer for measuring effective temperature is also described. Some measurements given show the variation of effective temperature and air temperature in warming up a room. W. S. S.

3483. Effect of Low Temperatures on Sensitivity of Radiometers. S. Smith. *Nat. Acad. Sci., Proc.* 16. *pp.* 373–376, *May,* 1930.

A description is given of a chamber suitable for the study of radiometers at low temperature. The radiometer was mounted in the inner chamber, and after the chamber had been thoroughly evacuated, the desired gas was introduced with precautions as to purity and dryness. Light from a controlled lamp was then allowed to fall on one of the radiometer vanes, and deflections were recorded for a series of different pressures. The cooling chamber was then filled with liquid air and the series repeated. The maximum sensitivity increases at low temperatures and shifts towards lower pressures. The radiometer becomes very sensitive to stray radiation at low temperatures, but this can easily be eliminated. J. J. S.

3484. Automatic Low-Temperature Thermostat (Cryostat). A. C. Egerton and A. R. Ubbelohde. *Faraday Soc., Trans.* 26. *pp.* 236–239, *May,* 1930.

Two controlling elements are present in this thermostat, designed to maintain a vacuum-jacketed bath of 500 c.c. of petrol at − 120° ± 0·1° C.: (i) Regulation to within 0·5° C. is ensured by immersing in the bath a double-walled metal vessel V containing liquid air, the level of which is maintained constant by an automatic siphon device; (ii) finer regulation is effected by automatic variation of the pressure of the gas between the walls of the vessel V and hence of the rate of transfer of heat from the bath to the liquid air. This control of pressure is obtained by immersing in the bath a constant-volume gas thermometer in which an electric contact is made or broken whenever the bath temperature passes through its mean value and thereby brings into action either a high- or a low-vacuum pump. The system uses only 200 c.c. of liquid air per hour and may be run at temperatures down to −160° C. L. V. C.

3485. Use of Grid-Glow Tube in Thermoregulator. J. H. Hibben. *Rev. Sci. Instruments,* 1. *pp.* 285–287, *May,* 1930.

A thermoregulator on the Wheatstone bridge principle has been evolved in which relays are used in the galvanometer circuit and the main circuit to control the current. To prevent sticking of the relays use can be made of a three-electrode valve instead of batteries. The grid-glow tube may be substituted for the valve. It consists of a cylindrical aluminium kathode, an anode and grid of Ni wire protruding from a glass tube, and contains neon gas at low pressure. The kathode to anode impedance is practically infinite, while the anode to kathode impedance at 8 milliamperes is 20,000 ohms. The potential of the grid is changed by the contact of the galvanometer-relay boom arm. A rectified current then flows from anode to kathode through the windings of the relay in the main circuit. The Wheatstone-bridge principle may be operated on either d.c. or a.c. and will automatically maintain the temperature of a furnace cavity at 1200° C. within 0·1° C. W. C. S. P.

3486. Furnace for Rapid Calibration of Thermocouples. F. Adcock. *Journ. Sci. Instruments,* 7. *pp.* 196–197, *June,* 1930.

A small electric furnace is described which enables a thermocouple to be calibrated by the " gold wire " method in about ten minutes. AUTHOR.

3487. Lag in Thermometers. A. T. Starr. *Phil. Mag.* 9. *pp.* 901–912, *May,* 1930.

Applies the operational calculus to the problem of the lag of a thermometer in a medium the temperature of which varies in a general manner. E. E. F. d'A.

3488. Relation of Current to Temperature in Pyrometric Filaments of Tungsten. G. Ribaud. *J. de Physique et le Radium,* 1. *pp.* 176–184, *May,* 1930.

Considerable study has been devoted to the relationship between long and short filaments from the point of view of the form of the curve representing the relationship between current and temperature, more particularly to the value of the ratio di/dt at a point on this curve. The author arrives at the conclusion that, in the main, for *long* tungsten filaments, whatever may be their form or dimensions, there is, at a given temperature, a fixed value, the same for all, for the value of the ratio $(1/I)(dI/dT)$ or $(1/I)(dI/dS)$ where S and T represent respectively the temperature of brilliance and the true temperature. Practical rules are given for the calculation of the ratio between the variation (dI) of the current, in the filament of an optical pyrometer, and the variation (dS) of the temperature of the source as it is observed, *i.e.*, its colour temperature or brilliance. Finally, taking into consideration the previous work of the author, the general form of equation is established for the relationships involved in the current/temperature curves for both long and short filaments of the same diameter. The calculated values obtained by the use of these curves are shown to be in excellent quantitative accord with direct measurements. S. G. B.

3489. Temperature Variation of Specific Heat of Oils. H. R. Lang and R. Jessel. *Inst. Petroleum Technologists, J.* 16. *No.* 82. *pp.* 476–500, 1930.

The oils studied are Pennsylvanian, Persian, Mid-Continent and Californian crude oils, together with the residues of the first three when topped to 100° C. The measurements were made by the continuous flow electrical method over the range from room-temperature up to about the temperature at which the lightest fractions commenced to boil. The curves in general pass through a minimum, the increase at the lower temperatures being attributed to the formation of waxes or other solid molecules, so that to change the temperature 1° C., the heat necessary to break up these molecular aggregates has to be supplied. This is supported by the fact that the crude and the topped oil show the same specific heat at temperatures below the minimum of the curve. The authors give the formula $s = 0{\cdot}00090t - 0{\cdot}499d + 0{\cdot}856$, where s = specific heat (cal. per gm. per 1° C.), t = temperature (° C.) and d = specific gravity at 60° C., relative to water at 60° C. It only purports to represent the results above the minimum. J. H. A.

3490. Vapour Pressures of Molten Mixtures of Lead Chloride and Lead Bromide at High Temperatures. K. Jellinek and A. Golubowski. *Zeits. f. phys. Chem.* 147. *Abt. A.* 6. *pp.* 461–469, *May*, 1930.

The partial vapour pressures of $PbCl_2$ and $PbBr_2$ in the molten state are determined for mixtures in all proportions at 660°, 700°, 740° and 780° C. The melts behave as ideal solutions, Raoult's law being valid over the whole range of composition. The molar heat of vaporisation for $PbCl_2$ and $PbBr_2$, in the pure state and in the mixtures, is 28,400 cal. over the range of temperature investigated. A. J. M.

3491. Entropies of a Crystal and its Fused Mass in Relation to the Temperature. G. Tammann. *Ann. d. Physik*, 5. 1. *pp.* 107–112, *May* 15, 1930.

The difference of the thermodynamic potential ζ of a body in the two conditions is $\zeta_2 - \zeta_3 = E_2 - E_3 - (\eta_2 - \eta_3)T + (v_2 - v_3)p$ . . .(1), where E represents the energy, η the entropy and v the volume of unit mass of the substance. The index 3 refers to the crystal; the index 2 to the supercooled liquid and at still lower temperatures to the supercooled liquid in the glass condition. At the melting point T_1, the equilibrium temperature of crystal and liquid, $\zeta_2 = \zeta_3$. Neglecting the pressure p as very small, $(E_2 - E_3)_{T_1} = (\eta_2 - \eta_3)T_1 = R$ . . . .(2), where R is the heat of fusion of unit mass. For any other temperature

$$(E_2 - E_3)_T = \int_T^{T_1} (\eta_2 - \eta_3)\,dT + (\eta_2 - \eta_3)T \;.\;.\;.\;.\;.\;.\;.\;.\;.\;\; (3).$$

Graphs are drawn for ethyl alcohol, plotting E and η in relation to T on the assumption that at $T = 0$, $\eta_2 = \eta_3$; whence from equation (2), $\eta_2 - \eta_3 = R/T_1$. But this relation is known to be untrue and it follows that at the absolute zero point the difference between the entropies of the glass and the crystal does not vanish, although the specific heats of glass and crystal are then not appreciably different. With ethyl alcohol and other substances, R/T_1 is greater than $(\eta_2 - \eta_3)_{T_1}$, but with glycerine the ratio is less. The author shows that the η-curve must be suitably displaced parallel to itself, and that with glycerine $\eta_2 - \eta_3$ changes its sign at T = 238° C., and a second equilibrium temperature is thereby indicated. T. B.

3492. Distribution of Non-Reacting Fluids in the Gravitational Field. M. Muskat. *Phys. Rev.* 35. *pp.* 1384–1393, *June* 1, 1930.

The paper consists essentially of an analysis of the equations given by

Lewis and Randall (*Thermodynamics*, p. 242) for the distribution of non-reacting ideal fluids in a gravitational field. When the fluids are incompressible a formal solution is obtained for a mixture of any number of constituents. But it has not been possible to put it into a form convenient for numerical application. The ratios of the concentrations of any constituent at the top to that at the bottom of a vertical column of the mixture are given explicitly, both for incompressible and compressible fluids. When all the molar volumes of the various fluids are equal the equations are solved completely and lead to a *relative* barometric distribution, and in the particular case of ideal gases, to individual barometric distributions. The physical meaning of this is briefly discussed. The case of binary mixtures is treated in detail, and numerical examples are given, first for a mixture of two paraffins, and secondly for a dilute solution of NaCl in water, which is equivalent to an ideal solution of liquids. As is to be expected, the effect is extremely small, and in the first case only one-tenth as large as is given by a simple barometric formula. AUTHOR.

3493. Equation of State of Solids at High Temperatures, and the Magnitude $\gamma = (dp/dt)_v \times v/R$. J. J. van Laar. *Zeits. f. Physik*, 62. 1–2. *pp*. 77–89, 1930.

Emphasises the fact that the rational form of the equation of state for this case is $p + a/v^2 - \lambda/v \times 1/(v-b) = RT/(v-b)$, and that $(dp/dt)_v = a/\sigma$ is hence equal to $R/(v-b)$. It follows that $\gamma = a/\sigma \times v/R = v/(v-b)$. A table is given in which the values of γ are given for a number of elements; these are related to the position of the elements in the periodic table. The alkali and alkaline earth metals, Zr, Ta, and the chromium group have, on the average, $\gamma = 4\cdot 0$; the group Mn, Fe, Cu, $\gamma = 7\cdot 1$; the Zn and Al groups, $\gamma = 5\cdot 5$; the Sn, Pb group, $\gamma = 7\cdot 1$; and the metalloids, $\gamma = 2\cdot 8$. Criticises the form of the equation of state for solids given by Grüneisen. H. N. A.

3494. Determination of c_p/c_v by a Precision Method. P. H. Brodersen. *Zeits. f. Physik*, 62. 3–4. *pp*. 180–187, 1930.

An elaboration of the method used by Ruchardt [see Abstract 1925 (1929)] and Rinkel [see Abstract 1520 (1930)]. The vibrations of the steel ball in the Ruchardt and Rinkel apparatus were photographed by means of a rotating mirror, and the record so obtained enlarged and measured. From the results so obtained, assisted by several corrections, the value of the ratio c_p/c_v for perfect adiabatic compression was calculated and obtained. The correction is given as $\Delta = 0\cdot 010$. The values of k so obtained are given as for air, $k = 1\cdot 400 \pm 0\cdot 003$ (somewhat lower when CO_2 and water vapour are present). For CO_2, $k = 1\cdot 292 \pm 0\cdot 004$. S. G. B.

3495. New Calculation of Heat of Rotation of Hydrogen at Low Temperatures. S. Däumichen. *Zeits. f. Physik*, 62. 5–6. *pp*. 414–418, 1930.

According to wave mechanics, hydrogen is composed of two modifications—a symmetric para-modification, and an antisymmetric ortho-modification. Values of the specific heat of rotation of the ortho- and para-forms are calculated for temperatures between 17° and 283° Abs.

J. S. G. T.

SOUND.

3496. Scattering of Sound Waves by Small Elastic Spheres. K. F. Herzfeld. *Phil. Mag.* 9. *pp.* 741–751, *May,* 1930. *Supplement.*

A theoretical treatment of the scattering of sound waves by small elastic spheres. The general problem of an elastic sphere in a fluid of moderate viscosity giving four unknown coefficients for longitudinal and transverse waves in sphere and liquid is solved. Extrapolation to a non-viscous fluid gives a result agreeing with Rayleigh's. W. H. Ge.

3497. Propagation of Sound in Suspensions. K. F. Herzfeld. *Phil. Mag.* 9. *pp.* 752–768, *May,* 1930. *Supplement.*

An attempt to simplify the measurement of the compressibility of a solid by measuring the velocity of sound in a liquid in which small particles of the solid are suspended. The treatment is theoretical. It is assumed that the particles are small isotropic spheres (random orientation of anisotropic particles), and that the small difference between adiabatic and isothermal compression of solids may be neglected, as may also be the small periodic temperature changes due to the adiabatic compression of the suspending liquid. Two methods of calculation are given, and solutions applicable to experimental conditions are under test. W. H. Ge.

3498. Velocity of Sound in Air, O_2 and CO_2 at High Temperatures. Temperature Coefficients of Molecular Heat. F. E. King and J. R. Partington. *Phil. Mag.* 9. *pp.* 1020–1026, *May,* 1930.

The method and apparatus used for measurements of the velocity of sound in air, O_2 and CO_2 were similar to those previously employed [see Abstracts 1791 (1927) and 897 (1929)], but the temperatures were higher (900° to 1200° C.) except for air, for which measurements up to 1300° C. have been given. Tables are given for the velocity of sound in each gas and for the molecular heats of CO_2 and O_2. The velocity in all three cases increases with temperature. As regards the molecular heats for CO_2 and O_2, both gases show a gradual rise with temperature of C_v and C_p, but the ratio C_p/C_v decreases with increasing temperature. A. W.

3499. Absolute Velocity Measurements with Hot Wires in Stationary Sound Waves. H. Müller and E. Waetzmann. *Zeits. f. Physik,* 62. 3–4. *pp.* 167–179, 1930.

The constant cooling effect which a hot wire experiences through the air vibrations in a sound wave were again investigated according to the method of Goldbaum and Waetzmann [see Abstract 2540 (1929)]. The discrepancy between the results obtained by the above-named workers and other observers was stated and discussed. Absolute measurements were made of the periodic cooling effect, and it was established that for the absolute measurement in sound waves of both the constant and periodic cooling effects on a heated wire, this can only be done successfully by taking special precautionary measures and for certain thicknesses of the wire. Full experimental and theoretical details are given. S. G. B.

3500. Generation of Sound by the Siren Principle. E. Simeon. *Phys. Soc., Proc.* 42. *pp.* 293–297; *Disc.,* 297–299, *June* 15, 1930.

The paper discusses various undesirable features of the simple siren, considered as a source of sound for technical work, and describes a siren with a reasonably pure note, whose intensity can be kept constant throughout a range of pitch from about 70 to 7500 cycles. AUTHOR.

3501. Strike Note of Bells. A. T. Jones. *Acoustical Soc. of America, J.* 1. *pp.* 373–381, *April,* 1930.

A more careful examination was made of the first seven partial tones of the six largest bells of the Dorothea Carlisle Chime. The pitches were determined with the aid of calibrated forks and the frequency of the strike note was judged to be that of an octave below the fifth partial, whether heard close to the bell or at a distance of 300 m. The time of contact of clapper and bell was about one-half the period of the fifth partial on the bell tested. No clear answer can yet be given to the question why the pitch of the strike note of the bell is judged to be an octave below the fifth partial. W. H. GE.

3502. Vibration of the Violin Body. H. Backhaus. *Zeits. f. Physik,* 62. 3–4. *pp.* 143–166, 1930.

The modes of vibration of the backs of three different violins at various frequencies are studied experimentally by a device, similar to the condenser microphone, which is applied at many different points of the violin back. W. H. GE.

3503. Oscillations of Thin Bars, Circular Diaphragms and Annuli. A. G. Warren. *Phil. Mag.* 9. *pp.* 881–901, *May,* 1930.

The effect of flexure of a diaphragm upon its acoustic output has been only roughly examined, but it looks as if the rigid disc theory must be abandoned. The author obtains some new mathematical data with regard to thin bars. E. E. F. d'A.

3504. Sound Field of a Circular Diaphragm. H. Backhaus. *Ann. d. Physik,* 5. 1. *pp.* 1–35, *May* 16, 1930.

Expressions are found for the velocity potential at any point in the sound field of a circular membrane surrounded by an infinite, rigid plane. Points lying within a hemisphere described on the membrane are not included. Airy's diffraction formula is obtained from the general result as a first approximation. The output of the membrane is calculated and agrees with Rayleigh's value, and the theoretical polar diagram for the membrane is confirmed by experiment. G. E. A.

3505. Propagation of Sound in Tubes. H. Tischner. *E.N.T.* 7. *pp.* 192–202, *May,* 1930.

Description of an arrangement for observing the course of the phenomena of the propagation of sound in tubes. Kirchhoff's theory is confirmed. J. J. S.

3506. Sense of Audition. P. A. Macdonald and J. F. Allen. *Phil. Mag.* 9. *pp.* 827–834, *May,* 1930. *Supplement.*

An examination of Weber's law as applied to hearing. A note of 180 hertz is produced by a Stern tonvariometer, and after two seconds the pitch is just perceptibly increased by the addition of a small weight to the air tank. Weber's law is not even approximately verified, the smallest audible increment not being proportional to the intensity. A much closer agreement is obtained by putting $1/\Delta I$ proportional to $\log I$. E. E. F. d'A.

ELECTRICITY AND MAGNETISM.

ELECTROSTATICS, TERRESTRIAL ELECTRICITY AND MAGNETISM

3507. Measurement of Small Changes of Capacity. K. Niemeyer. *Phys. Zeits.* 31. *pp.* 451–456, *May* 1, 1930.

A description is given of a simple and accurate method of measuring small changes of capacity by means of a valve arrangement with self-excitation. J. J. S.

3508. Dielectric Polarisation of Liquids. Part VIII. Acetic and Butyric Acids. C. P. Smyth and H. E. Rogers. *Am. Chem. Soc., J.* 52. *pp.* 1824–1830, *May*, 1930.

Previous work [see Abstract 2825 (1928)] includes a description of the apparatus used in the present investigation, which records measurements of the dielectric constants and densities of solutions of acetic and butyric acids at different temperatures. From the data obtained, the polarisations of the substances have been calculated. The dielectric constants of the pure acids behave abnormally in that they increase with rising temperature instead of decreasing. The results are shown to be consistent with the theory of the existence of the acids in single and double molecules, the latter of which have little or no electric moment. It is opined, however, that the molecular force fields may affect one another and cause further abnormalities. [See also Abstract 1544 (1930)]. H. H. Ho.

3509. Polar Molecules and their Contribution to Energy Loss in Dielectrics. F. Hamburger, Jr. *Phys. Rev.* 35. *pp.* 1119–1124, *May* 1, 1930.

Recently suggestion has been made that even at frequencies as low as those of commercial power circuits the theory of molecular orientation may serve as an explanation of at least a portion of the dielectric energy loss. This paper is an attempt to examine this suggestion on the basis of the Debye theory and the available experimental data. It reaches the following conclusions: (*a*) The contribution of molecular orientation to the energy loss at frequencies below 10,000 cycles per sec. is negligible at the temperatures of 0° C. and 10° C. for glycerine. (*b*) For temperatures higher than 10° C. the contribution becomes still smaller and in all probability vanishes. (*c*) The probability that any substantial portion of the normal dielectric loss found in the usual insulating oils, at commercial frequencies, may be accounted for on the basis of the Debye theory, is remote. (*d*) In order to determine the effect of the dipoles in their contribution to dielectric loss, very accurate determinations of the dielectric constant must be made, especially for those substances that show small changes in dielectric constant with temperature and frequency. AUTHOR.

3510. Evidence for Quantisation from the Electric Polarisation of Acetic Acid Vapour. Extension of van Vleck's Theory of Dielectric Polarisation. C. T. Zahn. *Phys. Rev.* 35. *pp.* 1047–1058, *May* 1, 1930.

The dielectric constant of acetic acid vapour has been measured at various pressures and temperatures, and the results indicate a departure from Debye's theory, which suggests an internal transition, with respect to temperature variation, from one type of single molecule to another. Near saturation there was detected a small amount of association of a kind increasing the molecular polarisation. The anomaly is discussed from the standpoint of the new quantum mechanics, and it is suggested that the effect is due to a transition from one state to a higher state of vibration associated with the OH group. The data are interpreted in terms of the extension of van Vleck's theory (see below). The Raman frequencies given by Dadieu and Kohlrausch indicate that the fundamental vibration frequency due to the OH group is of such a value as to produce transitions of quantum state in precisely the observed region of temperature and in agreement with the proposed theory. A discussion is given of the anomalous behaviour of other physical properties of the vapour, regarding it as a statistical distribution of molecules, surrounded by different force fields associated with the change in electric moment. The possibility of attributing previously observed discrepancies between refractivities and the optical parts of the dielectric polarisation to the above-mentioned type of quantisation is suggested. It is shown that van Vleck's theory (based on the assumption that the electric moment is fixed for all states of low energy) can easily be extended to include the effect of vibrational quantisation (where the electric moment depends on the vibrational quantum number) which may occur in the region of observed temperatures. Debye's equation no longer holds in its simple form, but in a sense it can be regarded to hold if the vapour be considered as a mixture of molecules statistically distributed in the vibration states. H. H. Ho.

3511. Multiple Association in Liquid Dielectrics. M. Wolfke. *Phys. Zeits.* 31. *pp.* 498–501, *May* 15, 1930.

Previous work [see Abstract 951 (1929)] has dealt with the simple association of dipole molecules in liquid dielectrics, and the present paper extends the mathematical treatment to multiple association, which is dealt with statistically and defined as the case where the resulting increased dipole moment of two associating dipole molecules is electrically neutralised by the incorporation of a third dipole molecule into the system. H. H. Ho.

3512. Electrical Charges of Thunderstorms. J. C. Jensen. *Monthly Weather Rev.* 58. *pp.* 115–116, *March*, 1930.

Records were obtained at Lincoln, Nebraska, of changes in the potential gradient during lightning discharge and the distance of the cloud, size of flash and part of the cloud flashing. 639 flashes showed a decrease of negative potential and 375 the reverse. The respective numbers of negative and positive flashes were for (1) distant, 177 and 122, (2) intermediate, 171 and 67, and (3) near, 298 and 196. The results agree well with Wilson's measurements and support his idea of the upper pole of the cloud being positive, but there are notable exceptions. The evidence generally favours Simpson's theory for the cyclonic type of storm, but the positive vortex is much larger in some than in others. For the active front of the cloud most discharges to the ground are forked downwards and in secondary parts the other type with upward branching predominates, but the results do not support Simpson's ideas regarding intensity of the flash. R. S. R.

3513. Identity of the Lightning Flash and the Sparks of Electrical Machines. E. Mathias. *Comptes Rendus*, 190. *pp.* 847–849, *April* 7, 1930.

Gray's conception is discussed by the author, who describes the apparatus used for the experiments and deduces from photographs taken of the spark that it is not definite in any way after a single discharge, but that its path is opened out by several preliminary discharges following one another in a jerky manner and always lengthening after each discharge. These preliminary flashes appear simultaneously on each pole, but are much longer and more forked from the positive pole. Each flash follows the path made by its predecessor, its own opening action commencing at the end of this path. Since lightning is only a colossal spark it was natural to apply to its study the same method as is used in the spark of an induction machine, but in the discharge of lightning, contrary to that of an induction spark, there is a sense in that all preliminary discharges come from the positive pole. This shows that Gray's conception is imperfect. T. C. H.

3514. Wireless Methods of Investigating the Electrical Structure of the Upper Atmosphere. Part II. E. V. Appleton. *Phys. Soc., Proc.* 42. *pp.* 321–339, *June* 15, 1930.

The comparative discussion of the various direct wireless methods of measuring the "equivalent" height of the atmospheric ionised region, begun in the first part of this paper [see Abstract 1261 (1929)] is continued so as to include the recently described moving-transmitter method of Mirick and Hentschel. [See Abstract 1920B (1929).] The relations between the optical and equivalent paths of waves deviated by the upper atmosphere and between the rates at which these quantities may vary with time are investigated theoretically, and, from the results of experiments carried out to test these relations, deductions are made concerning (*a*) the existence of more than one ionised region in the upper atmosphere, (*b*) the possible influence of magnetic storms on atmospheric ionisation, (*c*) the gradient of ionisation in the upper atmosphere and its alteration under solar influence at sunrise, and (*d*) the actual height reached by waves deviated in the upper atmosphere. AUTHOR.

3515. Auroral Observations at Lerwick Observatory, 1924–1929. A. W. Lee. *Meteorolog. Office, Prof. Notes, No.* 56. [11 *pp*], 1930.

Meteorological conditions at Lerwick Observatory were favourable for observations of aurora on 30 % of the evenings in the auroral seasons 1924–1929. Aurora was observed to occur on 59 % of these favourable evenings. The frequency of aurora is high from September to November, and from February to April, lower in December and January. Throughout the evening the frequency increases considerably from 19 h. to 21 h. then more gradually until 23 h.; the frequency of aurora showing ray structure is greatest at 21 h. In general, aurora and magnetic disturbance go together. There were, however, five occasions on which active aurora was observed, but the magnetograms showed no disturbance. AUTHOR.

3516. Zodiacal Light and Gegenschein as Phenomena of the Earth's Atmosphere. E. O. Hulburt. *Phys. Rev.* 35. *pp.* 1098–1118, *May* 1, 1930.

A quantitative atmospheric theory of the Zodiacal light and the Gegenschein is developed. Neutral particles are sprayed out in all directions from the earth's atmosphere, and at 50,000 to 70,000 km. levels are ionised by the ultra-violet light of the sun. The effect of the earth's magnetic field combined with the pressure of the sunlight produces an oval ring of ions stretching out away from the sun to 10^6 km. and makes a portion stream out like a comet's tail. The oval ring is the Zodiacal light and the comet's tail is the Gegenschein. Quantitative estimates lead to a low ion density in the Zodiacal ring and to a rate of escape of 10^{-6} of the entire atmosphere in 10^6 years. Helium probably escapes more rapidly than other gases, which may account for the surprisingly small quantity found in the atmosphere. J. G. H. B.

3517. Electric Conductivity of the Earth. I. Koenigsberger. *Phys. Zeits.* 31. *pp.* 487–498, *May* 15, 1930.

The vertical component of the magnetic field which is caused by induced currents is calculated. These currents are induced in an infinitely conducting hemisphere by a circular current of finite radius in a very thin wire which lies on the bounding surface of the hemisphere. Formulæ are deduced and the sources of error discussed. The theory is applied to the earth. The observations gave a resistance of the expected order of magnitude for the upper strata of the earth—3×10^4 ohm per c.c. To penetrate to depths of above 1 km. to 20 km. frequencies <500 H are required. J. J. S.

CURRENT ELECTRICITY, MAGNETISM AND ELECTRO-MAGNETISM.

3518. Theory of Conductivity. R. Peierls. *Ann. d. Physik*, 5. 2. *pp.* 244–246, *May* 27, 1930.

Supplementary notes to portions of two previous papers by the author. [See Abstracts 1912 and 2262 (1930).] J. J. S.

3519. Part of Protons in Electric Conduction in Metals. A. Coehn and W. Specht. *Zeits. f. Physik*, 62. 1–2. *pp.* 1–31, 1930.

Gives further particulars of the investigation of the problem. It has been found that the diffusion of hydrogen in a palladium wire can be followed over several cm. by means of potential measurements, and its relation to the temperature determined. The resistance of the wire is found to be independent of the distribution of the hydrogen along it. The resistance of palladium increases at first with the amount of hydrogen in it, beyond this point increase in the hydrogen diminishes the resistance. The hydrogen taken up after the maximum is reached escapes as soon as the charging electrolysis stops. When a current flows through the wire, part of it is carried by positively charged protons. Hydrogen moves to the kathode. The velocity of the movement, and its temperature coefficient, have been measured. No limit was found for the fall of potential below which the electrical transfer of the hydrogen vanished. The motion was followed down to 0·025 volt/cm. H. N. A.

3520. Theory of Superconductivity of the Elements. Part I. Thermoelastic Characteristic of Superconductors. Z. A. Epstein. *Zeits. f. Physik*, 62. 5–6. *pp.* 401–411, 1930.

Superconductors are characterised by relatively large coefficients of expansion α and of compressibility x. The author points out that while values of α and x differ for the various superconductors by as much as 50 %, and by very much more if tantalum be included, the ratio α/x differs only by, at most, 10 % from the mean value even when tantalum is included. Introducing the notion of interatomic compressibility β, defined by the equation $\beta = x/v^{2/3}$, v denoting atomic volume, the author shows that values of α/β for superconductors differ from the mean only by 5 %, and by 8 % only if tantalum be included in the discussion. The superconduction exhibited by the eutectic Au-Bi alloy is discussed, and an analogy between the superconducting and ferromagnetic elements referred to. J. S. G. T.

3521. Electrical Conductivity of Cu_3Au Alloys, with and without Superstructure, at Low Temperatures. H. J. Seemann. *Zeits. f. Physik*, 62. 11–12. *pp.* 824–833, 1930.

The electrical resistance of copper-gold alloys, containing very approximately 25 atomic % of gold, and either quenched after 50 hours annealing at 860° C. (without superstructure), or after 95 hours slow cooling from 400° C. to 300° C. (with superstructure), is investigated at temperatures down to $-252 \cdot 9°$ C. The former show a small linear decrease, the latter a considerably more marked decrease of resistance with fall of temperature. The dependence of resistance upon composition shows clearly, in the case of the latter alloys, the formation of the intermetallic compound Cu_3Au and confirms the hypothesis that the alloys with superstructure are to be regarded as solid solutions of copper and gold in the compound Cu_3Au. The resistance of this compound decreases at low temperatures in the manner characterising pure metals. [See Abstract 787 (1930).] J. S. G. T.

3522. "Reaction-Isochore" Equation for Ionisation within Metals. E. H. Hall. *Nat. Acad. Sci., Proc.* 16. *pp.* 371–373, *May*, 1930.

The author proposes a modification for the relation $U = kT^2 d \log K/dt$ called by Nernst the equation of the "reaction-isochore," which consists in multiplying the second member by some factor which ranges from 1·33 in nickel to about 3·13 in manganin. J. J. S.

3523. Apparent Deviation from Ohm's Law. H. M. Barlow. *Phil. Mag.* 9. *pp.* 1041–1055, *May*, 1930.

The author has repeated and extended Bridgman's experiments which seemed to indicate a definite increase in the effective resistance of gold and silver films to currents of the order of 10^6 amperes per sq. cm. The results obtained prove that Ohm's law is rigidly true for a gold conductor carrying a current density 2×10^6 amperes per sq. cm., and leave little room for doubt that the law is equally true at 3×10^6 amperes per sq. cm. The same conclusion holds for platinum at a current density of $1 \cdot 3 \times 10^5$ amperes per sq. cm. J. J. S.

3524. Probe Characteristics, Space Potentials and Electron Groups in the Tungsten Arc. M. Wehrli. *Helv. Phys. Acta*, 3. 3–4. *pp.* 180–204, 1930. *In German.*

Measurements were made of the probe characteristics of stationary probes in a tungsten arc in nitrogen at a pressure of 260 mm., both near the anode and near the kathode. Under these experimental conditions the probes are caused to glow and for this reason the behaviour of glowing probes, heated by some external means, was specially investigated. A definite connection was found between the position of the space charge and the probe characteristic. The kathode fall of potential calculated from the space potential was found to be nearer to that obtained by the method of impeded discharge than to the value determined statically. In front of the kathode three electron groups were found: a primary mobile group, a secondary group with an electron temperature of 43,000° K., and third irregular group at 11,000° K. In the middle of the arc the primary group is small and only a secondary group at 79,800° K. is found. In front of the anode is found only the irregular group with a high temperature of 121,000° K. [See Abstract 2555 (1929).] A. W.

3525. Kathode of an Arc Drawn in Vacuum. R. Tanberg. *Phys. Rev.* 35. *pp.* 1080–1089, *May* 1, 1930.

It has been found that the kathode is the only electrode which contributes vapour for the maintenance of an electric arc under very low gas pressure. The velocity of this vapour was determined by two methods. Method 1 consisted of measuring the force of reaction of the vapour on the kathode and the rate of vaporisation of the kathode material. Method 2 consisted of determining the force exerted by the vapour on a vane suspended in front of the kathode spot and the rate of vapour condensation on the vane. Both these methods gave a vapour velocity of the order of 16×10^5 cm./sec. A temperature of around 500,000° K. results when this value for the kathode vapour velocity is substituted for c in the equation: $\frac{1}{2}mc^2 = 3KT/2$. AUTHOR.

3526. Form and Structure of Sparks. T. Terada, U. Nakaya and R. Yamamoto. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 245. pp. 207–230, *May* 20, 1930. *In English.*

The faintly luminous brushes accompanying long sparks have been photographed using a quartz-fluorite objective. It is shown that the different forms of long sparks studied are accompanied by quite characteristic brushes. For example, the " zig-zag " spark is developed from a network of tree-like brushes, while the " three-part " spark is determined by the positive and negative pilot brushes and the short spark connecting the ends of these brushes. The characteristics of these brushes in oxygen, nitrogen, carbon dioxide and some aliphatic halogen derivatives are described. The origin of the " three-part " spark is discussed. The paper is illustrated by a large number of photographs of the sparks. F. J. W.

3527. Oscillations in Glow Discharge in Neon. G. W. Fox. *Phys. Rev.* 35. *pp.* 1066–1072, *May* 1, 1930.

Radio-frequency oscillations consisting of one or two fundamentals, together with a series of harmonics for each fundamental, have been observed in large current glow discharges in neon. The observed frequencies lie in the range from approximately $1\cdot5 \times 10^4$ to 2×10^5 cycles per sec. The oscillations are very sensitive to pressure changes, their frequency increasing rapidly with decreasing gas pressure. The oscillation frequency also increases markedly with increasing current. The frequency is quite independent of resistance in series with the discharge. The suggestion is made that the oscillations are due to the presence of a reversed electric field in the negative glow of the discharge. AUTHOR.

3528. Conductivity of a H.F. Discharge in Hydrogen. C. J. Brasefield. *Phys. Rev.* 35. *pp.* 1073–1079, *May* 1, 1930.

Measurements were made of the voltage between electrodes necessary to produce a current of 100 milliamperes in the discharge for gas pressures between 0·005 mm. and 1·0 mm. and for frequencies of oscillation between 1·25 and 20 million cycles per sec. (wave-lengths between 240 and 15 m.). It was found that the discharge has its maximum conductivity when operated at a frequency of 15 million cycles (20 m.) and a pressure of 0·015 mm. A theory of the mechanism of the h.f. discharge indicates that under these conditions an electron makes an inelastic collision with a gas molecule every electronic mean free path having been under the influence of the electric force for one half-cycle. The theory also indicates that for any frequency of oscillation greater than 15 million cycles, both the electric force and the gas pressure, for which the conductivity is a maximum, will increase directly with the frequency of oscillation. AUTHOR.

3529. Gas Discharge in Hydrogen. Part II. E. Lau and O. Reichenheim. *Ann. d. Physik,* 5. 2 *pp.* 296–304, *May* 27, 1930. *From the Reichsanstalt.*

The influence of concentration of added gases, pressure, current strength, and shape of the discharge tube have been studied in the production of the blue striæ in the hydrogen discharge. The continuous hydrogen spectrum is very prominent in the blue striæ while the many-lined spectrum is quite weak. The results show that the continuous spectrum is due to the dissociation of the hydrogen molecule into atoms as a result of electronic collisions. The excitation potential for this is below that required for the excitation of the many-lined spectrum. Further, the experiments have indicated a method of measuring the excitation potentials of other gases. [See also Abstract 1976 (1930).] F. J. W.

3530. Potential Fall between Striæ in Electrical Discharges through Rarefied Hydrogen. J. Zeleny. *Frank. Inst., J.* 209. *pp.* 625–638, *May,* 1930.

The variation with pressure of the potential fall between striæ in the positive column of the hydrogen discharge has been studied. It is shown that as the pressure increases the potential fall steadily increases also. The anomalous manner in which the distances between the striæ change with increase in the gas pressure finds, therefore, no counterpart in the influence of gas pressure on the potential drop between striæ. The colour of the striæ is bluish when the pressure is such that the distance between them is a minimum and reddish at other pressures. It is shown that the blue light can only arise from an excited state of the molecule having an energy of at least 14·5 volts above the ground level. Under pressure conditions which are such that the energy acquired by the electrons is less than this, it is necessary to assume that they obtain the required addition in collisions of the second kind with molecules of impurities having much lower excitation levels than those possessed by hydrogen. [See also following Abstract.] F. J. W.

3531. Potential Relations in the Striated Positive Column of Electrical Discharges Through Hydrogen. J. Zeleny. *Phys. Rev.* 35. *pp.* 699–704, *April* 1, 1930.

A further discussion is given of the results described earlier. [See preceding Abstract.] F. J. W.

3532. Ionisation of Hydrogen by Single Electron Impact. W. Bleakney. *Phys. Rev.* 35. *pp.* 1180–1186, *May* 15, 1930.

From an analysis of the theoretical potential energy curves for the H_2 molecule as outlined by Condon the theoretical predictions for the types of ions resulting from primary impacts with electrons are described. These predictions include the formation of H_2^+ at 15·25 volts, H^+ at 17·9 volts, H_2^+ at about 30 volts which then dissociates with several volts kinetic energy, and H_2^{++} at about 50 volts which also dissociates with kinetic energy. Using a mass spectrograph, the experimental results of a study of the primary ions in hydrogen indicate the formation of H_2^+ at

15·4 ± 0·1 volts, H^+ at 18·0 ± 0·2 volts, and H^+ at 26 to 30 volts, the last having various amounts of kinetic energy. Curves are given showing the relative number of each of these types of ions from which it appears that at the higher velocities about 92 % of the total number of ions formed is of the H_2^+ type, 1 % of the H^+ corresponding to the 18-volt potential, and 7 % of the H^+ having kinetic energy. The probability of ionisation for all types together as a function of the electron velocity is given by a curve, plotted to an arbitrary scale, which exhibits a well-defined maximum at 60 volts. AUTHOR.

3533. Uniform Positive Column of an Electric Discharge in Mercury Vapour. T. J. Killian. *Phys. Rev.* 35. *pp.* 1238–1252, *May* 15, 1930.

The uniform positive column was studied in a long cylindrical tube by means of the Langmuir probe electrode method. Measurements were made of space potentials, random electron current densities and the electron temperatures along the axis and across a diameter of the tube for vapour pressures from 0·27 to 7·13 baryes. Mean free paths calculated from electron mobilities by Langmuir's formula were found to be in fair agreement with those obtained by other investigators from angular scattering experiments. The results obtained tend to the conclusion that at vapour pressures above 1·4 baryes the ionisation is accounted for by the direct impacts with neutral atoms of electrons whose velocity distribution is Maxwellian. At lower vapour pressures it seems necessary to assume the presence of a larger number of higher speed electrons than would be found in a Maxwellian distribution. A. W.

3534. Electron Energy Losses in Mercury Vapour. C. W. Foard. *Phys. Rev.* 35. *pp.* 1187–1194, *May* 14, 1930.

An improved magnetic spectrum method was used to determine the energy losses sustained by slow-speed electrons in mercury vapour. Electron energies up to 60 volts were used, the main region of interest being from 0 to 25 volts. The energy losses detected, below that required for ionisation, were: 4·9, 5·4, 6·7, 7·7, 8·8, 9·8 volts. These correspond to practically all the transitions of a valence electron from the basic 1S level up to each of the higher levels to 4P. No evidence of other losses such as are observed by the photoelectric method was found. At voltages above 10·5, the ionisation potential, electrons seem to be able to give up any quantity of energy in excess of that required for ionisation, the higher losses being favoured. A very interesting loss of 11·07 volts has been found which has not been recorded heretofore. It begins to be resolved at about 18 volts, and grows steadily with increasing voltage in much the same way as the 6·7-volt loss. This loss is thought to involve the simultaneous displacement of both valence electrons from their normal levels. AUTHOR.

3535. Activation and Ionisation by H.F. Rotating Fields. W. Lüdke. *Zeits. f. Elektrochem.* 36. *pp.* 298–300, *May*, 1930.

Discusses means of producing rotating electrostatic fields, analogous to the familiar rotating magnetic fields, and their probable action on atoms and molecules. J. H. A.

3536. Mobility of Ions in Air. J. L. Hamshere. *Roy. Soc., Proc.* 127. *pp.* 298–314, *May* 7, 1930.

The method used is an improved form of that previously described [see Abstract 2567 (1929)], giving higher resolving power. Distribution curves (*i.e.*, curves showing the relation between di/dk and k, where i is current and k mobility) are given for dry air, and for three concentrations each of water, methyl alcohol and ethyl ether vapours in air. The results show distribution bands of width at least double that to be expected from a unique mobility—in dry air substantially more than double, the upper and lower limits and peak value being respectively: (negative ions) 2·1 ± 0·05, 1·6 ± 0·1, 1·8 ± 0·1; (positive ions) 1·35 ± 0·05, 0·78 ± 0·05, 1·1 ± 0·1, thus confirming previous results. With water vapour there is a narrowing of the negative ion band, which is shifted normally, *i.e.*, towards lower mobility; the positive band is scarcely affected. With methyl alcohol Tyndall and Philips' results [see Abstract 2431 (1926)] are accurately confirmed for negative ions, less so for positive, the slower ions completely disappearing in presence of the vapour. Ether affects the positive ions more than the negative, these latter scarcely at all. The results are discussed and a modification of Loeb's cluster theory suggested as affording at least a qualitative explanation. C. A. S.

3537. Motion of Slow Positive Ions in Gases. J. S. Thompson. *Phys. Rev.* 35. *pp.* 1196–1216, *May* 15, 1930.

The motion of cæsium positive ions in hydrogen and helium has been studied particularly in the region of low velocities, as well as the absorption of lithium positive ions in helium. It is found that in all cases the cæsium ions are retarded, the ion energies being distributed approximately canonically about the average retarded value. The retardation is proportional to the pressure. The data give values for the radius of the positive cæsium ion of 1·78 Å. in helium and 3·19 Å. in hydrogen. The absorption of lithium positive ions has been studied by three methods for velocities of 20 to 900 equivalent volts, the coefficient of absorption C being determined by two of them. The general dependence of C on the ion velocity is found to be the same for the two types of apparatus used, but the values are found to depend on the dimensions of the absorbing chamber. No general retardation of the lithium ions is observed. It is concluded that no absolute significance can be attached to the values of the atomic radii determined from measurements of this kind. F. J. W.

3538. Mobility of Ions in Ionic Rays. W. Frohberg. *Ann. d. Physik*, 5. 1. *pp.* 59–72, *May* 16, 1930.

Continues a paper by Köther [see Abstract 2127 (1927)] on the same subject; his results are subject to criticism since the ions were produced by heating a salt on an electrode at the bottom of the chamber, with the result that the motion of the ions towards the other electrode was affected by convection currents in the contained air or other gas. The a.c. method of Rutherford was employed. The author has repeated the investigation, placing the heated electrode, covered with silver chloride, at the top of the chamber, and has measured the mobility in different gases. The values obtained are less than those of Köther for the reason stated above. The mobility increases with the frequency of the alternating field. Moisture diminishes the mobility, which alters very greatly when the temperature of the salt is increased. Silver ions in CO_2 show two discrete values for the mobility. H. N. A.

3539. Absorption Coefficient for Slow Electrons in Gases. C. E. Normand. *Phys. Rev.* 35. *pp.* 1217–1225, *May* 15, 1930.

The absorption coefficient has been measured in H_2, He, A, Ne, N_2

and CO for electrons with velocities corresponding to 0·5 to 400 volts. As a result of the high resolving power of the apparatus, fine structure was found in the curves of all the gases. A minimum in the absorption coefficient curve was found in every case at velocities between 0·7 and 1·1 $(\text{volts})^{1/2}$. A lack of agreement between the present measurements at velocities below 2 volts and recent results of Ramsauer and Kollath appears to be due to a difference of about 0·5 volt in the velocity scales of the two sets of observations. AUTHOR.

3540. Motion of Electrons in Carbon Monoxide. H. B. Wahlin. *Phys. Rev.* 35. *pp.* 1568–1571, *June* 15, 1930.

With the same data as were presented in an earlier paper [see Abstract 2932 (1926)] it is shown that K. T. Compton's theory of electron mobilities holds within the limits of experimental error for high pressures and low fields, on the assumption that the energy loss of the electrons on impact with the molecules is greater than that due to momentum transfer. The electron mean free path in CO has been calculated and, when the electrons are in thermal equilibrium with the gas, is 0·069 cm. at pressure 1 mm. AUTHOR.

3541. Reflection of Lithium Ions from Metal Surfaces. R. B. Sawyer. *Phys. Rev.* 35. *pp.* 1090–1097, *May* 1, 1930.

A study has been made of the reflection of lithium ions from reflectors of platinum foil and of nickel crsytals deposited on tungsten foil. Movable ground joints in the tube were completely eliminated in order to prevent contamination of the reflector surfaces by grease. Readings were taken with both cold and hot reflectors. Spodumene was used as a source of ions and reflection was studied in the meridian plane only. Superposed on a diffuse scattering of ions were two reflected beams. One was reflected nearly specularly, as found by Read and by Gurney, the angle of maximum reflection, however, being independent of accelerating potential. The other beam appeared only at voltages above 200 and was composed of ions most of which had retained 80 % or more of their original energy. This beam was found between the incident beam and the normal to the surface, at angles independent of the accelerating potential up to 700 volts. This independence of angle on voltage forbids diffraction interpretations. A tentative explanation is to suppose specular reflection from the (110) planes of the nickel crystals, but the agreement is not entirely satisfactory. AUTHOR.

3542. Liberation of Electrons from Metal Surfaces by Positive Ions. M. L. E. Oliphant and P. B. Moon. *Roy. Soc., Proc.* 127. *pp.* 373–406, *May* 7, 1930.

Part I. Experimental. A fine beam of "monochromatic" helium ions of energy ranging from 20 to 1000 volts, was obtained by inserting a probe electrode perforated by a narrow canal, into strongly ionised helium gas. The helium ions issuing from the canal were allowed to fall on a suitable target of molybdenum, nickel or tungsten, and the amount and character of the secondary electron emission was determined (*a*) by a retarding potential method, (*b*) by magnetic analysis. The results show the variation of total electron emission with the energy of the positive ions and with their angle of incidence on the target. For the velocity distribution of the emitted electrons it was established that after continued heat treatment of the target and purification of the helium, the distribution curves showed a number of maxima of which the most prominent and consistent in occurrence were situated at electron energies of 2·5, 6·8, 17·0, and 20 volts.

The effect of changing the energy of the positive ions was to alter the shape of the curve without, however, changing appreciably the positions of the maxima. A trace of impurity was sufficient to mask the characteristic maxima. Part II. Theoretical. After a general discussion of current theories of the electrical conditions near a metallic surface, an approximate calculation of the probability of neutralisation of an impinging positive ion before impact is made using Nordheim's formula for autoelectronic emission. It is shown that such neutralised ions on reaching the surface will give rise to secondary electrons whose energies lie between two limits which for He ions incident on Mo equal 2·5 and 16·0 volts respectively. Ions which are not neutralised before penetrating the surface should give rise to secondary electrons between two limiting energies which for Mo equal 6·8 and 20·3 volts respectively. Thus, all the experimentally observed maxima in the distribution curve are accounted for. The part played by the kinetic energy of the ions in producing electron emission is also examined. W. S. S.

3543. New Photoelectric Effect in Alkali Cells. E. Marx. *Phys. Rev.* 35. *pp.* 1059–1065, *May* 1, 1930.

If two monochromatic beams fall simultaneously on an alkali electrode a new photoelectric effect is shown as follows: If the intensity of the high-frequency light ν_1 is sufficient to establish the limiting potential corresponding to the Einstein law, the presence of any component of lower frequency ν_2 diminishes the potential according to the following equation $R = c\,(n_2/n_1)\,.\,(\nu_1/\nu_2)\,(\nu_1 - \nu_2)h/e$, where R is the potential decrease and n_2/n_1 the ratio of the electronic emission of the two components, measured by the test cell itself. A tentative explanation of the phenomenon is advanced. AUTHOR.

3544. Space-Distribution of X-Ray Photoelectrons Ejected from the K and L Atomic Energy Levels. C. D. Anderson. *Phys. Rev.* 35. *pp.* 1139–1145, *May* 15, 1930.

A Wilson expansion chamber was used to study the space-distribution of photoelectrons ejected from a gas by monochromatic X-rays. In agreement with Auger [see Abstract 2273 (1929)] and Watson and van den Akker [see Abstract 1988 (1930)], a more isotropic space-distribution was found for electrons ejected from the L energy levels than for those ejected from the K energy level. The distribution of the electrons from the L energy levels became less isotropic with an increase in frequency of the incident radiation. For a given radiation, the average forward momentum of the electrons from the K energy level was found to decrease with an increase in the binding energy of the parent atom. Within experimental error, however, for electrons from the K energy level, even for different binding energies, the average forward momentum remained the same for a given velocity of ejection of the electron. The average forward momentum of electrons from the L energy level was greater than that for electrons from the K energy level for a given velocity of ejection. The space-distribution of electrons from the K energy level was in fair accord with the recent results of quantum mechanics. AUTHOR.

3545. Photoelectric Effect in Semi-Insulators. R. Fleischmann. *Ann. d. Physik*, 5. 1. *pp.* 73–106, *May* 16, 1930.

AgS_2, AgI, AgBr, AgCl, CuO, Cu_2O, Cu, fuchsine and cyanine are examined for photoelectric effect for a given amount of energy down to a

wave-length of 1850 Å. The external photoelectric effect is independent of the conductivity and varies but slightly from the effect in metals.
E. E. F. d'A.

3546. Apparatus for Testing Photoelectric Cells in Sunlight. J. Kunz and V. E. Shelford. *Journ. Sci. Instruments*, 7. *pp.* 191–193, *June*, 1930.

A description is given of an apparatus for the testing of photoelectric cells in sunlight. It consists essentially of a large light-tight box with the necessary adjustments, containing specially constructed rotating sector discs and a Macbeth illuminometer. AUTHORS.

3547. Scattering of Particles by Fields of Force. G. Beck. *Zeits. f. Physik*, 62. 5–6. *pp.* 331–351, 1930.

Shows that the phenomena of scattering can be regarded as due to resonance effects of the incident particles with virtual quantum states in the continuous spectrum, and are in close analogy with the optical phenomena in thin sheets. Considers the relation between the eigenfunctions in the continuous spectrum in a potential "cup," reflection of particles at a potential cup, passage of particles through a Gamow potential threshold. The general considerations lead, when applied to the distribution of potential calculated by Hartree for the interior of the atom, to Holtsmark's theory of the Ramsauer effect, and, when applied to the distribution of potential in the nucleus suggested by Gamow, to the anomalous α-particle scattering observed by Rutherford, the results of the theory being in qualitative agreement with the observations. H. N. A.

3548. Polarised Electron Waves. E. Fues and H. Hellmann. *Phys. Zeits.* 31. *pp.* 465–478, *May* 15, 1930.

Bohr has shown that a direct demonstration of the electron spin by a Stern-Gerlach experiment can never be accomplished, owing to the masking effect of electron diffraction. Although the polar character of the electron particle cannot therefore be established experimentally, the polar properties of the Dirac electron probability current can be deduced and experiments can be devised to demonstrate them. The author examines mathematically the possibility of obtaining a polarised electron wave by extracting electrons from states in which orientation is known to have taken place (*e.g.*, from the hydrogen atoms of one stream in the Stern-Gerlach experiment, by photoelectric effect). It appears that theoretically a polarised electron wave can be obtained in this way. For the detection of polarisation in an electron stream it is shown that the scattered electron distribution when the beam impinges on an aggregate of orientated atoms enables the direction of the polarisation to be determined. The behaviour of polarised electron waves in a magnetic field and in reflection and transmission by a potential barrier is also worked out. W. S. S.

3549. Constant Frequency Oscillator. C. W. Miller and H. L. Andrews. *Rev. Sci. Instruments*, 1. *pp.* 267–276, *May*, 1930.

The frequency of a valve oscillator depends not only upon the constants of the oscillating circuit, but also upon those of the tube itself. In a tuned plate circuit operating with minimum coupling, the influence of the tube on frequency depends only on its plate resistance, and decreases as the plate resistance is increased. The steady drift in frequency usually observed is due mainly to the effect on the plate resistance of progressive changes in the filament. Due to their rugged filaments the UX852 and the screen grid UX860 have been found particularly suitable for steady oscillators. Two methods of compensating for small changes in plate voltage and filament emission are described. A curve is included showing the effect of temperature on the frequency of the oscillator. The apparatus used for this precise study of small frequency changes is described. One of its most valuable features is an audio oscillator which is controlled by a vibrating string. AUTHORS.

3550. Modes of Vibration of a Round Plate Cut from a Quartz Crystal. A. M. Skellett. *J.O.S.A.* 20. *pp.* 293–302, *May*, 1930.

A large number of modes of vibration of a round quartz crystal plate of the Curie cut were photographed by means of the ionised gas appearing at the antinodal regions when the plate was mounted in an atmosphere of neon or argon at a few mm. pressure and thrown into vibration piezoelectrically by a radio-frequency oscillator. Two general types of vibration of the plate were found. In the first kind the plate was symmetrically divided up into nodal and antinodal regions forming patterns peculiar to the exciting frequencies. In the second kind, of which less evidence was found, the vibration consisted of standing waves along chords or diameters of the plate with reflection at the edges. The crystal rested on a round brass plate which served as the lower electrode. Two different top electrodes were used, a point and a screen, the same pattern being photographed with each for the more prominent modes of vibration, and from this it was concluded that the patterns were independent of the electrode arrangement. Evidence of vibration along axes oblique to the surfaces of the crystal plate was found. All vibrations observed were believed to be compressional in nature. AUTHOR.

3551. Potential Measurement of Rapid Electromagnetic Vibrations by Means of the Kerr Effect. L. Pungs and H. Vogler. *Phys. Zeits.* 31. *pp.* 485–487, *May* 15, 1930.

Description of an arrangement in which the electro-optic Kerr effect is used to measure h.f. tensions. The following conditions must be fulfilled: the Kerr effect must be independent of the frequency and there must be no inertia phenomena, the two tensions which are compared must be approximately of sine form. The method was proved in a range of potential from 700 to 3500 volts; with higher potentials there are no difficulties. J. J. S.

3552. Theory of Ferromagnetism. E. Teller. *Zeits. f. Physik*, 62. 1–2. *pp.* 102–105, 1930.

A proof is given of the theorem, put forward by Heisenberg, that in an atom lattice with one valency electron per atom, the state of highest multiplicity is the state of least energy if all the interchange integrals are positive, and is the state of maximum energy if all the interchange integrals are negative. W. S. S.

3553. Constant of the Molecular Field. Equation of State both Magnetic and Calorimetric. P. Weiss. *J. de Physique et le Radium*, 1. *pp.* 163–175, *May*, 1930.

Phenomena which have been interpreted in the molecular field are of two kinds, in possible relationship to the ferromagnetic equation of state or to the calorimetric properties. The first concerns the correction of the equation of state of the molecular field with regard to the term h_m and the second with regard to the molecular field energy H_m. Various hypotheses are discussed with reference to the relationship between the two molecular fields and the facts favourable to the simple assumption h_m

$= n \cdot \sigma$, where n is a constant and σ the magnetisation value. The study of the magnetisation of nickel gives rise to an objection to the first decisive view founded on the curvature of the line $\sigma =$ constant. This objection is raised, taking into account the non-agreement of the experimental equation of state for a substance formed of atoms which are movable but have fixed moments, and that the validity is better established for nickel on the basis of a variable constitution from 3 to 8 magnetons. The discussion of the calorimetric measurements and the experimental values obtained establishes the fact that the molecular field is given by $n \cdot \sigma$ for high temperatures and low magnetisation, as also for low temperatures and saturation magnetisation, where the coefficient n retains the same value although the moment of the atoms may have been changed. S. G. B.

3554. Magnetic Characteristics of Nickel. F. Tyler. *Phil. Mag.* 9. *pp.* 1026–1038, *May*, 1930.

Curves showing the variation of the spontaneous magnetisation of nickel with temperature below the Curie point are derived from the quantum and classical theories and are compared with experimental results. Curves corresponding to large external fields are also considered. The comparison shows that the variation of σ/σ_0 with $a(= \mu H/kT)$ is closely given by a tanh curve, indicating that the carriers have a moment of one Bohr magneton; σ here is the specific intensity and σ_0 the saturation intensity of magnetisation. There seem to be anomalies in the variation of magnetisation close to the Curie point. The magnetic data for temperatures above the Curie point are also discussed. It is possible to explain most of the magnetic characteristics by supposing that the carriers are free electrons whose numbers may vary, as suggested by Dorfman's work. There are, however, several objections to this hypothesis. A. W.

3555. Magnetic Moments of Atomic Nuclei. J. Dorfman. *Zeits. f. Physik*, 62. 1–2. *pp.* 90–94, 1930.

Shows, as in a recent paper, that neither of the isotopes Li_7 nor Li_6 can have a nuclear magnetic moment of the order of magnitude of one Bohr magneton. Be^{++} has five electrons in the nucleus and is diamagnetic as are C and N (in all cases where the outer electron system is " closed "). He is also diamagnetic, so that the author concludes that nuclei containing 2, 3, 4, 5, 6, 7 electrons have no magnetic moment of the order of magnitude $1M_B$. This agrees with the spectroscopic data. P. Curie has found that $RaCl_2$ is paramagnetic, though the ions Ra^{++} and Cl^- have the rare gas configuration, so that the outer electrons do not produce paramagnetism. Possibly part of the substance was decomposed by its own radiation, and some metallic radium was present which is apparently paramagnetic; or perhaps the preparation was not perfectly pure. A large magnetic moment of the Ra nucleus would strongly influence its spectrum; this does not appear to have been observed. It is necessary to assume either that the spins of the nuclear electrons are in some way mutually compensated, or that they lose their spin when they enter a nucleus, or, finally, that there are actually no electrons inside the nucleus. H. N. A.

3556. Theory of the Magnetisation Curve. R. Becker. *Zeits. f. Physik*, 62. 3–4. *pp.* 253–269, 1930.

The energy of a cubic lattice from dipoles parallel amongst themselves is only dependent on the direction of the dipoles if the lattice is subjected to an elastic deformation. The discussion of the formula expressing this yields an explanation of the actual course of the technical curves of magnetisation. J. J. S.

3557. Relativistic Mechanics in Fermi-Dirac Statistics and the Magnetic Susceptibility of Gases at High Temperatures. K. Basu. *Zeits. f. Physik,* 62. 3–4. *pp.* 279–288, 1930.

Starting from Fermi-Dirac statistics the weight factor is deduced by means of Fowler's method, on the basis of the Schrödinger equation, from the classical viewpoint and making the relativity correction. The energy and entropy values are calculated by means of Hankel's functions. Attention is called to the deviation from the Sackur-Tetrode expression for the entropy, and a derivation of the form of the magnetic susceptibility of gases at high temperatures, as those in the interior of stars, is given. This has a certain analogy with the classical formula of Langevin. H. N. A.

3558. Magnetic Susceptibility of Gases. Part I. Pressure Dependence. F. Bitter. *Phys. Rev.* 35. *pp.* 1572–1582, *June* 15, 1930.

A method is described for measuring the magnetic susceptibility of gases which has certain advantages over those used by previous observers. It is found that the volume susceptibility of CO_2, N_2 and H_2 is proportional to the pressure. Deviations from proportionality of the type observed by Glaser [see Abstract 2832 (1929)] are found in the above gases upon introducing water vapour as an impurity in amounts probably less than a few hundredths of 1 %. AUTHOR.

3559. Quantisation of Wave-Field. L. Rosenfeld. *Ann. d. Physik,* 5. 1. *pp.* 113–152, *May* 16, 1930.

A general Lagrangian function being given as a function of the coordinates and field variables it is proposed to find the Hamiltonian equations of motion and *vertauschungs* relations of a quantised system in motion in the field. The theory is based on the theory of groups. The Lagrangian function is considered as a scalar density with respect to a certain group of transformations of the coordinates and field variables. From this certain identities between the field variables and their conjugate " momenta " are derived. These identities lead to values of the time-derivatives of the field variables in terms of the momenta, the field variables themselves and a set of arbitrary functions of time and position. The Hamiltonian of the motion can now be derived and the canonical equations of motion written down. The *vertauschungs* relations follow from the transformation theory. The infinitesimal transformations of the group considered are worked out and it is shown that the formulæ are covariant. Finally, the theory is applied to the Lagrangian function of the Fock-Weyl relativistic treatment of the quantum theory of the electron, and such results as the continuity-equation for electricity and the conservation of angular momentum are obtained. G. C. McV.

3560. Some Properties of Spherical Harmonics. H. Bateman. *Am. Math. Soc., Bull. pp.* 306–314, *April,* 1930.

The method of projection is employed to derive a number of relations between spherical harmonics. J. S. G. T.

3561. Electromagnetic Field Exterior to a System of Perfectly Reflecting Surfaces. F. H. Murray. *Nat. Acad. Sci., Proc.* 16. *pp.* 353–357, *May,* 1930.

Weyl has investigated the problem of " Hohlraumstrahlung " by making use of the properties of a certain vector solution of Laplace's equation, represented as the sum of potentials of a single and a double layer. The corresponding properties of a vector solution of the wave equation in three dimensions are here employed to determine the reflected field resulting when an electromagnetic field is modified by the presence of perfectly reflecting surfaces. The problem is reduced to the solution of a system of integral equations of the Fredholm type, in which the integration is extended over the reflecting surfaces, and the existence of an unique solution is established. J. S. G. T.

3562. Electrical and Other Dimensions. W. N. Bond. *Phil. Mag.* 9. *pp.* 842–847, *May*, 1930. *Supplement.*

The Maxwell-Thompson-Bridgman system is supported, in which the dielectric constant and the magnetic permeability are dimensionless numbers. Objections to this system disappear when it is understood that the dimensions of a quantity which is measured in derived units, form merely an abbreviated statement of how the derived unit was defined, indicating how its magnitude will change when the magnitudes of the arbitrary primary units are altered, and not representing a unique property of the thing being measured. A second part of the paper deals with the frequency of occurrence of fractional indices in dimensional formulæ. W. S. S.

3563. Most Probable 1930 Values of the Electron and Related Constants. R. A. Millikan. *Phys. Rev.* 35. *pp.* 1231–1237, *May* 15, 1930.

The conclusions are reached that: (1) no such empirical oil-drop formula as that suggested by H. A. Wilson can be valid; (2) it is highly improbable that the spectroscopic fine structure constant can be a whole number—either 136 or 137; (3) the most probable 1930 values of e, N, and h are the same as in 1917, corrections due merely to new determinations of the velocity of light and the absolute value of the ohm being alone needed. These values so corrected are: $e = (4{\cdot}770 \pm 0{\cdot}005) \times 10^{-10}$, $h = (6{\cdot}547 \pm 0{\cdot}011) \times 10^{-27}$, $N = (6{\cdot}064 \pm 0{\cdot}01) \times 10^{23}$; (4) if Lewis and Adam's theoretical equation is considered valid the probable errors are much smaller than the foregoing estimates. AUTHOR.

APPARATUS AND INSTRUMENTS.

3564. New High-Potential Electrometer. T. Wulf. *Phys. Zeits.* 31. *pp.* 315–323, *April* 1, 1930.

The electrometer consists essentially of a metallic strip which is attracted by a charged electrode. The moving system and electrode are enclosed in an earthed case, the movement of the string being examined in a microscope. Precautions are necessary to insure that the measuring microscope does not disturb the field. The instrument can be made to measure up to several thousand volts. G. E. B.

3565. Valve Electrometer. H. Nelson. *Rev. Sci. Instruments,* 1. *pp.* 281–284, *May*, 1930.

An account of a specially constructed valve which can be used for the accurate measurement of currents as small as 10^{-14} A. The valve is fitted with a nickel anode in the form of a grid; the oxide coated filament is supported at the centre of the anode by a piece of mica attached to the anode. Surrounding these in turn are a nickel cylinder, which serves as a control grid, and then a second cylinder to act as an electrostatic shield.

The control cylinder is supported by a lead brought out at the top of the tube; the control is thus disposed so that the resistance between it and the other electrodes is as high as 10^{16} ohms under normal operating conditions. The filament is heated to a low emission temperature and the anode is maintained at a positive potential of about 4½ volts with respect to the filament. The control cylinder may be fixed at any negative potential with respect to the filament. The current to be measured is made to charge the control cylinder, and its resulting change in potential is measured indirectly by the change in the current between the filament and anode. W. C. S. P.

3566. Modified Randall Universal Calibration Curve for Ballistic Galvanometers. R. H. Frazier. *Rev. Sci. Instruments,* 1. *pp.* 277–280, *May,* 1930.

An experimental-graphical method is given for the determination of the critical damping resistance of a ballistic galvanometer. The curve used turns out to be a modification of the Randall universal calibration curve [see Abstract 1203 (1925)], which can be represented in the region of underdamping by a very readily drawn straight line with a maximum error of 1·8 %. AUTHOR.

3567. Measurement of the Mean Value of a Current. G. W. Bowdler. *Journ. Sci. Instruments,* 7. *pp.* 151–157, *May,* 1930.

Two null methods of measuring the mean value of a current are described, and the precautions to be observed in each case are examined. Finally, the two methods are simultaneously applied to the measurement of rectified a.c., the frequency of which is varied between 50 and 4000 ∼ per sec. The results obtained by the two methods agree in every case to a few parts in 10,000. Calibration of a permanent magnet moving-coil ammeter by these two methods indicates that no appreciable error arises when instruments of this type are used to measure rectified a.c. whose frequency lies within the above-mentioned range. AUTHOR.

RADIOGRAPHY AND ELECTROPHYSIOLOGY.

3568. Production of Fever in Man by Short Radio Waves. C. M. Carpenter and A. B. Page. *Science,* 71. *pp.* 450–452, *May* 2, 1930.

The increase of body heat during fever, etc., may be a protective process rather than a sign of disease, as formerly supposed. Methods available for raising the body temperature are described. Whitney, of the G.E.C. laboratory, has observed an elevation of body temperature in men working in the field of a short-wave transmitter and, as a result, experimental work was carried out to adapt this energy for the production of artificial fever, for therapeutic purposes. The apparatus is similar to that used in wireless telegraphy except that, instead of an aerial, two condenser plates are used between which the patient is placed and subjected to frequencies of 10,000 to 14,000 kilocycles and a 3000-volt potential fall. The protection of the patient and the means of support are described. The actual temperature has been raised from 99·6° F. to 106·5° F. and could be further increased if desired. Twenty-five patients have been so treated, as well as animals. Beneficial results are claimed. B. J. L.

CHEMICAL PHYSICS AND ELECTROCHEMISTRY.

3569. Heat of Adsorption of (a) Oxygen and (b) Alcohol Vapours on Charcoal. H. K. Cameron. *Faraday Soc., Trans.* 26. *pp.* 239–248, *May,* 1930.

Continuing the work and employing the methods of McKie [see Abstract 875 (1929)], the author confirms the latter's discovery of a maximum when the heat of adsorption of oxygen is plotted against surface concentration; the maximum value, about 71,000 cal./gm. mol., is indicated at a concentration of 0·14 gm. mols. oxygen per gm. charcoal. Three methods are described for introducing alcohol vapour into the apparatus. The results for n-propyl alcohol and iso-amyl alcohol (16,400 and 17,700 cal./gm. mol. respectively) are of the same order as those found by other workers and show no dependence upon surface concentration down to concentrations of 10^{-5} gm. mol. per gm. charcoal. L. V. C.

3570. Sorption of Ammonia by Charcoal. J. Sameshima. *Chem. Soc. Japan, J.* 5. *pp.* 173–180, *May,* 1930. *In English.*

The sorption velocity of ammonia by sugar charcoal has been measured over a period of six months in order to arrive at the equilibrium condition, and from one hour forward can be expressed by the equation $x = \mathrm{K} \log t + k$, where x is the sorption amount, t the time, and K and k are constants. The mechanism is discussed, and it is concluded that the sorption velocity depends upon the dissolution velocity of ammonia molecules into the narrow molecular cavities of charcoal. H. H. Ho.

3571. Connection between Gaseous Content and Adsorption of Electrolytes by Activated Carbon. Part III. Platinised Carbon as Hydrogen Electrode. B. Bruns and A. Frumkin. *Zeits. f. phys. Chem.* 147. *Abt. A.* 1–2. *pp.* 125–146, *April,* 1930.

The formation of a double layer on the surface of platinised carbon saturated with hydrogen is accompanied by a consumption of gaseous hydrogen. The hydrogen enters the aqueous solution in the form of hydrogen ions, so that the surface of the carbon becomes negatively charged and attracts kations out of the solution. In consequence, a certain volume of hydrogen disappears if alkali is adsorbed by platinised carbon in an atmosphere of hydrogen. This hydrogen is set free again on desorption of the alkali by addition of acid. The results indicate that with higher concentrations of acid a reversal of the charge on carbon saturated with hydrogen is possible. When kations are adsorbed on the surface of platinised carbon which is saturated with CO, a quantity of CO equivalent to the amount of kation adsorbed is converted into CO_2. [See also Abstract 2849 (1929) and following Abstract.] A. J. M.

3572. Adsorption of Electrolytes by Activated Carbon. A. Frumkin. *Kolloid Zeits.* 51. *pp.* 123–129, *April,* 1930.

Summary of recent work at the Karpow Chemical Institute, Moscow [see Abstracts 2848 and 2849 (1929)]. When platinum black is saturated with hydrogen and immersed in a neutral electrolyte, it sends H-ions into the solutions and attracts the kations of the solution, taking itself a negative charge. When sugar carbon, full of ash and activated at 1000° in a current of Cl_2, is similarly immersed in neutral salt solutions, it attracts the acid ion and behaves thus like an oxygen-gas electrode, so that the solution turns alkaline, whilst inorganic bases are not adsorbed. After expelling all gas from the carbon by treating for hours, electrolytes, HCl or NaOH, are no longer adsorbed, at least not from diluted capillary and inactive solutions. But the presence of air or oxygen restores the adsorption. This oxygen electrode is, however, not reversible. It is further noteworthy that suspensions of carbon charged with oxygen are much more stable in acid than in alkaline solutions, while the opposite holds for carbon charged with hydrogen. Suspensions of degassed carbon coagulate in a few hours, when gas-charged particles remain in suspension for days. [See also preceding Abstract and following one.] H. B.

3573. Adsorption of Ions and Potential of Electrodes: A New Quantitative Example. E. Lange and R. Berger. *Zeits. f. phys. Chem.* 147. *Abt. A.* 6. *pp.* 470–472, *May*, 1930.

The general validity of the empirical relation $\Delta x = \Delta lna$, where x is the quantity of potential-determining ions adsorbed under certain conditions, and a the activity of the ions in the solution, is discussed. This relation is shown to hold in the results of Bruns and Frumkin [see preceding Abstract] on platinised carbon, and is also confirmed experimentally for the hydrogen electrode under the same conditions. A. J. M.

3574. Adsorption of Gas Mixtures on Glass. C. Drucker and J. Marxen. *Zeits. f. phys. Chem.* 147. *Abt. A.* 5. *pp.* 371–395, *May*, 1930.

The rate of adsorption of hydrogen and carbon dioxide, on glass wool, both separately and together, has been determined. The adsorption isotherms have also been measured. Hydrogen is adsorbed only to a slight extent on dry glass wool over the pressure range of 1–0·2 atmosphere. The adsorption is much more considerable when the glass wool is wet. Carbon dioxide is adsorbed strongly by dry glass wool and even more strongly when the glass wool is wet. The rate of establishment of the adsorption equilibrium is great on dry glass wool, but is much slower when the glass is wet. The greatest observed thickness of the adsorption layers on moist glass was $1 \cdot 10^{-8}$ cm. for hydrogen and $26 \cdot 10^{-8}$ cm. for carbon dioxide. Hydrogen is adsorbed from the mixtures of the gases only when its relative partial pressure is high. F. J. W.

3575. Theory of Condensation and Adsorption. N. Semenoff. *Zeits. f. phys. Chem.*, 7. *Abt. B.* 6. *pp.* 471–479, *May*, 1930.

The Frenkel formula for the relation between the critical temperature for the condensation of a metallic vapour and the density of the vapour has been developed statistically. The treatment is extended to the consideration of the possibility of the formation of multimolecular layers during the adsorption of gases and vapours. F. J. W.

3576. Dark-Field Microscopy of Very Thin Films on Liquid Surfaces. H. Zocher and F. Stiebel. *Zeits. f. phys. Chem.* 147. *Abt. A.* 6. *pp.* 401–435, *May*, 1930.

Dark-field observation is employed as a subsidiary means for investigating unimolecular films. With aliphatic compounds these films become homogeneous under slight compression. In the case of a number of substances limiting values are observed during the passage from the flat to the steep portion of the pressure-surface curve, these apparently separating regions of high from those of low density. Under high compression colloidal particles separate and occasionally redissolve; the collapse can be followed in detail by the means used. Other substances, for some of which mesophases also are known, do not form homogeneous films. Ethyl p-azoxybenzoate gives a film which in the cold consists of a network and in the hot of colloidal particles with intense Brownian movement. Albumen gives either homogeneous films or colloidal particles embedded in a solid film, according to the conditions, and cellulose derivatives form homogeneous films or non-homogeneous networks, according to the nature of the preparation. Rubber forms homogeneous films under no experimental conditions and gives only coarse individual particles which may be squeezed together to a non-homogeneous skin. It is often not possible to decide if a film is solid or liquid, many films appearing to behave like soft, plastic masses. T. H. P.

3577. Structure in Very Permeable Collodion Gel Films and its Significance in Filtration Problems. W. J, Elford. *Roy. Soc., Proc. Ser. B.* 106. *pp.* 216–228, *April*, 1930. *Roy. Soc., Proc.* 127. *p.* 479, *May* 7, 1930. *Abstract.*

Optical studies of permeable collodion films have revealed the existence of two very definite types of structure—(i) microgel structure of microscopic order, and (ii) ultragel structure of ultra-microscopic order. The general nature of these structures has been established for several different nitro-cottons and the conditions determining them investigated. Gelation in this particular instance is a process of phase transition resulting from the coagulating influence of desolvation. The precise nature and stability of the gel is a function of the specific characters of the nitro-cellulose and solvent, and the variation in free surface forces around the dispersed phase particles with differing degrees of molecular complexity of the system. The bearing of these observations upon ultra-filtration has been discussed. A complete explanation of the general behaviour of ultra-filter membranes is afforded, and a sound basis established for the interpretation of filtration results. AUTHOR.

3578. Changes of Physico-Chemical Properties in the Transition Zone between Colloidal and Molecular Disperse Systems. Part III. Wo. Ostwald and A. Quast. *Kolloid Zeits.* 51. *pp.* 273–282, *May*, 1930.

This paper continues previous work [see Abstract 3424 (1929)] in which it was shown that a whole series of dyestuffs, which were very different chemically, exhibited a maximum dispersivity in aqueous alcohol of about 50 %. In consequence of the results thereby obtained, doubt has been thrown on the validity of the theoretical results of Einstein and others concerning particle size, and Fürth's formula, $D = x^2 f(v)^t$, where D is the diffusion coefficient, x the diffusion range, v the dilution and t the time, is now investigated by means of Auerbach's apparatus. Eight tables of recalculated data are given for night blue, nerol, sulphoncyanine, brilliant green, crystal violet, new fuchsine, benzopurpurine and Congo red. The forms of the new curves and positions of the maxima correspond to those from the older data but are steeper and more strongly defined. Further work is in progress. H. H. Ho.

3579. Work and Heat of Swelling. R. Fricke and J. Lüke. *Zeits. f. Elektrochem.* 36. *pp.* 309–320, *May*, 1930.

By means of a static differential method the vapour pressures of hydrogels of agar-agar, casein and maidenhair after hydration and dehydration may be measured to within ± 0·01 mm. of mercury. The gels of agar-agar and casein show marked hysteresis regions, but those of maidenhair exhibit relatively rapid adjustment of the vapour pressure and no hysteresis. Calculation of the maximum differential work of swelling A and the differential heat of swelling U shows that U always differs considerably in magnitude from A, and in the regions of greatest heat gradient, where calculation of U from the vapour pressure data is possible with greater certainty, U is always appreciably greater than A. The same holds for the integral heats and works of swelling. The approximate equality between $U_2 - U_1$ and $A_2 - A_1$, observed by Katz (*Kolloidchem. Beih.* 9. p. 106, 1917) with gels poor in water, holds over certain ranges of concentration for agar-agar and maidenhair. [See also Abstract 819 (1930).] T. H. P.

3580. Micro-Crystals in Bent Wires of Tungsten and Molybdenum. T. Fujiwara. *Kyoto Coll. Sci., Mem.* 13. *pp.* 109–116, *March*, 1930. *In English.*

The arrangement of the micro-crystals in a bent wire of tungsten, which was initially composed of a large single crystal, was studied by means of X-rays. The orientations of the micro-crystals produced by the destruction of the crystal at the time of bending are seen to be so scattered, to some extent around the initial orientation, that the orientations vary continuously from one part of the bent wire to the other, by keeping the initial crystallographic direction parallel to the axis of bending unaltered. In the case of the bent wire of molybdenum, which is not annealed after the drawing process, the common axis of the initial fibrous arrangement of the micro-crystals in the drawn wire is seen to have curved almost along the axis of the wire without destroying the initial fibrous arrangement. AUTHOR.

3581. Recrystallisation of Aluminium. K. Tanaka. *Kyoto Coll. Sci., Mem.* 13. *pp.* 117–125, *March*, 1930. *In English.*

Crystals produced by recrystallisation in slightly deformed single crystals of aluminium show a tendency to have a certain definite orientation with reference to that of the mother crystal, though the scattering of their orientations is considerable. Of the crystals thus obtained, several types with twin-like orientation are observed. The effect of the direction of the stress applied to the mother crystal before annealing and the mode of the destruction of the crystal caused by such stress exercise a small influence upon the orientation of the new crystals. AUTHOR.

3582. Prevention of Crystal Growth by Weak Deformation. A. E. van Arkel and J. J. A. P. van Amstel. *Zeits. f. Physik*, 62. 1–2. *pp.* 43–45, 1930.

The authors had shown [see Abstracts 400 and 401 (1929)] that crystals of aluminium and tin may recrystallise and grow at higher temperature at the expense of deformed crystals, but only if not themselves deformed. This is important for crystallisation even from melts. New experiments to demonstrate these effects are described. Technically pure aluminium is rolled down to a thickness of 650 μ, and incisions are made in the plate which is then heated to 600° C. to assume a homogeneous fine grain. Under tensile stress the partial strips stretch by about 2 %, but not uniformly. The elongation is very strong at the corners, and crystals

form especially near the cuts. On renewed stretching and reheating, more crystals formed, but the already deformed crystals did not grow. Further cuts were then made electrolytically, and it was observed that a crystal might grow on the one side and be consumed on the other.
H. B.

3583. Recrystallisation of Stretched Single Crystals of Tin. A. E. van Arkel and J. J. A. P. van Amstel. *Zeits. f. Physik,* 62. 1–2. *pp.* 46–48, 1930.

Former experiments indicated that the number of recrystallisation germs forming after deformation of aluminium or tin was the greater, the greater the previous hardening of the single crystals. This seemed to contradict Polanyi, according to whom new crystals grow during recrystallisation from the transition zone into the stretched zone of tin crystals. The crystals were obtained by drawing out fused tin into a thread or band. Contrary to Polanyi, the authors observed that the elongation did not take place in the form of a contraction of area at some spot, but was uniform over the whole length of the band, in some part of which a crystal would form. In some cases contraction started at some spot of the flat thread and spread from there. To obtain elongation with typical transition zones, the threads were embedded in fused pizein and stretched with the pizein blocks. The germs then appeared to form mainly in the thread; very few appeared in the less-hardened transition zones. H. B.

3584. Equilibrium Diagram of Iron-Vanadium System. M. Ôya. *Tohoku Univ., Sci. Reports,* 19. *pp.* 235–245, *May,* 1930. *In English. Report No.* 243 *from the Research Inst. for Iron, Steel and Other Metals.*

Metallic vanadium of 98·4 % purity was obtained by the thermite process, using a little less metallic aluminium than the theoretical and using Na_2CO_3 as the flux. The equilibrium diagram of the iron-vanadium system in the solid state has been investigated by making thermal, magnetic and microscopic analyses. The alloys of this system form a continuous series of solid solutions. With the addition of vanadium, the A_4 transformation of iron is lowered, while the A_3 is raised, so that the A_4 and A_3 curves meet at 2·5 % content of vanadium to form a continuous phase boundary. The A_2 point is raised, gradually at first, up to a maximum at nearly 15 % V, then lowered rapidly, until it reaches room temperature in an alloy containing nearly 35 % V. AUTHOR.

3585. X-Ray Investigation of Iron and Manganese Alloys. A. Ôsawa. *Tohoku Univ., Sci. Reports,* 19. *pp.* 247–264, *May,* 1930. *In English. Report No.* 244 *from the Research Inst. for Iron, Steel and Other Metals.*

An X-ray analysis has been made of the iron-manganese system throughout its whole range. Hardness and density measurements were also made for the alloys containing from 0 to 50 % of manganese. Four phases were found in the system by these measurements, that is, α- and β-manganese, the body-centred phase (α-iron), and the hexagonal phase (Fe_5Mn). At a sufficiently high temperature, a solid solution of γ-iron and γ-manganese is found in the whole range of the system. The lattice constants of different modifications of pure manganese (α, β and γ) decrease with an increasing content of iron; while the lattice constants of the modifications (α and γ) in iron increase a little with the concentration of manganese. AUTHOR.

3586. X-Ray Investigation of Copper-Antimony Alloys. E. V. Howells and W. Morris-Jones. *Phil. Mag.* 9. *pp.* 993–1014, *May*, 1930.

Nine alloys containing from 4 to 80 % antimony were examined by the powder method [see Abstract 3675 (1929)]. Starting from the copper end of the diagram, alloys containing up to 7 % antimony are solid solutions (α-phase) with the face-centred cubic structure of copper, a_0 increasing from 3·610 to 3·670 Å. As antimony increases from 7 to 30 %, the α-phase gradually changes to the γ-phase, which is hexagonal and occurs alone for 30 to 39 % antimony, a_0 increasing from 2·728 to 2·766 Å. Though 39 % corresponds to the composition Cu_3Sb, there is no evidence of this being a chemical compound. From 39 % antimony to the composition Cu_2Sb, the γ-phase and the definite compound Cu_2Sb occur. This is tetragonal, unit cell containing 2 molecules, $a_0 = 4\cdot026$ Å., axial ratio 1·524. It forms no solid solutions. From this point to 100 % antimony there is a mixture of Cu_2Sb and antimony, the rhombohedral lattice ($a_0 = 6\cdot235$ Å., $\alpha = 87° 24'$) of which is confirmed. There is no trace of any solid solution—the ϵ-phase of Carpenter, whose work is otherwise confirmed. It was impossible to determine the structure of the β-phase, which exists above 430°, passing into γ at that temperature. The results agree with those of Westgren, Hägg and Erikson [see Abstract 843 (1930)]. C. A. S.

3587. Behaviour of Single Crystals of Antimony under Alternating Torsional Stresses. H. J. Gough and H. L. Cox. *Roy. Soc., Proc.* 127. *pp.* 431–453, *May* 7, 1930.

Describes experimental work carried out with the object of determining the slip planes and slip direction of metallic antimony and investigating the production of twins and the identification of the twinning planes. Shows that the specimen did not deform by " slip " and that no slip bands were observed. A number of fine lines or cracks were found. The twinning planes of antimony were identified as of the 011 type; twins were observed on all three planes (011, 101 and 110) of this type. The " mirror image " nature of the structure within the primary twin bands was established by observation of secondary twins and other markings within the bands. The cracks and fracture followed, in general, well-defined crystallographic planes. As no definite slip bands were observed, the nature of the dependence of slip on the maximum linear and planar atomic densities could not be investigated. C. O. B.

3588. Behaviour of Single Crystals of Zinc under Alternating Torsional Stresses. H. J. Gough and H. L. Cox. *Roy. Soc., Proc.* 127. *pp.* 453–479, *May* 7, 1930.

The slip plane of zinc is the basal plane (0001); the slip direction is the most highly stressed primitive direction; deformation by slip is controlled by the criterion of maximum resolved shear stress. The twinning planes of zinc are the six planes of the general type $10\bar{1}2$. It is concluded, from an examination of the twinning planes, that the occurrence of twins as well as slip bands is controlled by the simple criterion of maximum resolved shear stress on the slip plane. [See also Abstract 2084 (1929).]

C. O. B.

3589. Rates of Second-Order Gas Reactions. L. S. Kassel. *Nat. Acad. Sci., Proc.* 16. *pp.* 358–364, *May*, 1930.

The rate of second-order gas reactions is customarily expressed by the equation $-dN/dt = Ze^{-E/RT}$, where Z represents the number of collisions between reactant molecules, and E is an empirically determined energy of activation. Reasons against the acceptance of this equation as a representation of experimental result are briefly discussed; it is known to be incorrect in the case in which the reverse of a bimolecular reaction is also bimolecular. A theory, which predicts that the linear increase of the probability of reaction with the energy of collision shall fail at temperatures only slightly higher than those yet attained in the case of hydrogen iodide decomposition, is developed and discussed. Numerical results of this theory are probably substantially correct. It appears to be unreasonable to express the temperature dependence of second-order reactions by a single constant energy of activation, or to regard the agreement between rate of reaction and the product of the collision number and the exponential as having any considerable theoretical significance. J. S. G. T.

3590. Ignition Temperatures of Gases in Nitrous Oxide. H. B. Dixon and W. F. Higgins. *Manchester Phil. Soc., Mem.* 73. *pp.* 21–32, 1928–1929.

The ignition temperatures of ether, ethylene and hydrogen in nitrous oxide were determined. A small jet of the combustible gas was made to issue at intervals from a narrow silica tube in the centre of a large cylinder, in which the " atmosphere " was maintained. The " gas " and " atmosphere " were heated to the same temperature in an electric furnace. It was found that the ignition temperature of hydrogen in air rose rapidly for the first four days, and then more slowly, and at the end of the ninth day the rapid ignition point had risen to within 5° of its normal value. The ignition point of hydrogen in oxygen and nitrous oxide was found to be nearly the same. The addition of oxides of nitrogen to the gas had the effect of lowering the ignition point, probably due to the formation of peroxides. Ether showed a low ignition point in oxygen, but in air it was unexpectedly high at atmospheric pressure, and varied greatly with changes in pressure. In nitrous oxide under normal pressure the ignition temperature of ether vapour was higher than in air and far higher than its ignition temperature in oxygen. F. J. B.

3591. Nature of Activation Heats and their Calculation from Band Spectra Data. D. S. Villars. *Am. Chem. Soc., J.* 52. *pp.* 1733–1741, *May*, 1930.

Chemical reaction is most probable when the kinetic energy of the resulting equals that of the reacting molecules, and will occur only in those cases where the sum of the potential energies of the colliding molecules plus the heat of reaction equals the sum of the potential energies which the resulting molecules would have if their respective nuclei undergo no change in position during the change in allegiance. The heat of activation, then, is the sum of the vibrational energies of the colliding molecules plus their heat of repulsion at the distance at which collision occurs. The foregoing principles have been applied to the hydrogen iodide decomposition with satisfactory numerical results. H. H. Ho.

3592. Quantitative Theory of Homopolar Combination (Lithium Li_2). M. Delbrück. *Ann. d. Physik*, 5. 1. *pp.* 36–58, *May* 16, 1930.

A mathematical analysis, with the aid of the exchange integrals of Heitler-London [see Abstract 1826 (1928)], of the chemical linkage in the molecule of lithium, Li_2, and an inquiry into the suitability of these integrals for such calculations. The linkage is weaker in Li_2 than in H_2. This is not to be ascribed to a repulsion between the two K shells, which is negligible in lithium, but to the exchange phenomena of the L-electrons. The case of hydrogen is different, because the two proper functions of hydrogen are different. No general conclusions can be drawn. H. B.

3593. Velocity of Monomolecular Reactions. J. Frenkel. *Zeits. f. Physik*, 62. 1–2. *pp.* 49–53, 1930.

The monomolecular reactions are, with reference to the views of Polanyi and Wigner, considered as evaporation of the molecules concerned, in which, however, for each molecule its own effective temperature is assumed, which is proportional to the energy of vibration of the atoms and is distributed for the various molecules according to Boltzmann's law (with the given mean temperature of the whole system). The results of Polanyi and Wigner thus appear as the limiting case for very complex molecules and to need a not unimportant correction for molecules as N_2O_5. J. J. S.

3594. Chemical Changes under a Strong Electric Field. T. Aono. *Chem. Soc. Japan, J.* 5. *pp.* 169–173, *May*, 1930. *In English.*

Description is given of a new method for the application of extremely powerful electric tensions to gases and dielectric liquids and for the acceleration of their reactions, temperature and catalysis being also taken into account. The cases studied were: Reduction of nitrobenzene, methylene blue and benzaldehyde; hydrogenation of oleic acid, silkworm pupa oil, cod-liver oil, fish oil, soya-bean oil and olive oil; organisation of oleic acid and olive oil; chlorination of acetic acid; interaction of nitrogen and hydrogen in oleic acid to form ammonia. H. H. Ho.

3595. Synthesis of Phosgene by Light and by α-Radiation. H. N. Alyea and S. C. Lind. *Am. Chem. Soc., J.* 52. *pp.* 1853–1868, *May*, 1930.

The photochemical synthesis of phosgene from CO and Cl_2 is expressed kinetically by $+ dP_{COCl_2}/dt = k\sqrt{I_{abs.} \times P_{CO}} \times P_{Cl_2}$. If the gaseous mixture is activated by α-particle bombardment instead of by light, the reaction obeys the same equation i_p, the number of ion pairs produced being substituted for $I_{abs.}$, the number of quanta absorbed. This holds over an eighty-three-fold range of radon concentration and a wide variation of the relative pressures of CO and Cl_2. Simultaneous measurement of the α-particle and photochemical reactions shows that the yield per ion pair is equal to the yield per quantum absorbed; this is also true in presence of oxygen (less than 10 %), which retards the reaction. With exceedingly weak radiation, yields as high as 85,000 molecules per ion pair are obtained, the more intense light radiations giving 5000 molecules per quantum absorbed. The secondary steps in the synthesis of phosgene involve an atomic chlorine chain mechanism and the above results show that this mechanism occurs independently of whether the primary step is photochemical excitation or ionisation by α-particles. T. H. P.

3596. Photochemical Hydrogen-Oxygen Reaction. G. B. Kistiakowsky. *Am. Chem. Soc., J.* 52. *pp.* 1868–1874, *May*, 1930.

The effects of the two spectral regions 1719–1725 Å. and 1854–1862 Å. on the oxygen-hydrogen reaction are widely different. The longer wavelengths produce only ozone in amount equal to that produced in similar oxygen-nitrogen mixtures, but in light of the shorter wave-length the yields of ozone in presence of hydrogen are smaller and hydrogen peroxide is also formed. The probable mechanism of the reaction is discussed and the probability of the reaction $O + H_2 = OH + H$ is estimated to 10^{-4}, a much smaller value than that predicted theoretically. T. H. P.

3597. Photo-Effect on Ions in Solutions. K. Butkow. *Zeits. f. Physik,* 62. 1–2. *pp.* 71–76, 1930.

Results are given of an investigation of the action of visible and ultra-violet radiation on aqueous solutions of KI, NaI, CsI, KBr and KCl, the photo-effect, that is, a process in accordance with the equation $X^- + h\nu = X + e$, being considered. The observed limits of the photo-effect agree well with the edges of the absorption bands of the halogen ions. When solutions of sodium, potassium or cadmium iodide in alcohol are irradiated with ultra-violet light, free iodine also appears. T. H. P.

3598. Mechanism of a Simple Voltaic Cell. R. T. Lattey and M. W. Perrin. *Faraday Soc., Trans.* 26. *pp.* 227–233, *May,* 1930.

Simple voltaic cells of the type $Zn/ZnSO_4/Cu$ formed a deposit on the positive pole and this deposit contained the metal of the negative pole. When the cell was short-circuited the deposit consisted of hydrated oxide of zinc and metallic zinc. In a boiling solution of zinc sulphate metallic zinc was deposited on the copper. In order to account for this a theory was advanced, according to which metallic ions from the solution tend to be discharged on the positive pole with the formation of an alloy. Dissolved oxygen in the solution oxidised the deposited metal thus acting as a depolariser. The film thus formed is porous and through this more oxygen diffuses and more metal is deposited from its inner surface. Experiments which showed the change of e.m.f. of the cell with the variation of the areas of copper immersed, with different resistances, and in the presence and absence of dissolved oxygen were carried out with $Zn/ZnSO_4/Cu$, and with $Cd/CdSO_4/Cu$ cells and the results were in general agreement with the theory. F. J. B.

3599. Ageing of Standard Cells: Increased Accuracy in Use: and International Comparisons. A. N. Shaw, H. E. Reilley and R. J. Clark. *Roy. Soc., Phil. Trans.* 229. *pp.* 125–162, *May* 12, 1930.

The work was begun by H. L. Callendar in 1896 on the absolute measurement of the e.m.f. of the normal Weston standard cell. The investigation was continued by H. T. Barnes and A. N. Shaw. The main contributions of the present article are: Neutral Weston standard cells are shown to age for at least twenty years according to the equation $E_M = A + B \log (M + \tau)$, where E_M is the change in voltage for an age of M months, and A, B and τ are constants. An initial reference mean for voltage was shown to be recaptured from time to time to within one or two parts in a million, without the construction of new cells. This is regarded as a definite advance in precision. Tables and curves are given which involve many hundred readings taken over a period of twenty years. A table and chart of international comparisons of the revised McGill readings with those of the National Physical Laboratory, England, and the Bureau of Standards are included. These show the average differences obtained by measuring exchanged cells. F. J. B.

3600. Location of E.M.F. in the Photovoltaic Cell. W. N. Lowry. *Phys. Rev.* 35. *pp.* 1270–1283, *May* 15, 1930.

A method was developed to utilise a 4-element vacuum tube to measure small potential differences. The so-called photovoltaic e.m.f. appears to be a modification of the electrolyte with light, there being no indication of any effect due to the direct illumination of the electrode or the boundary region between the electrode and the electrolyte. In certain types of experiments with these cells, current measurements cannot be regarded as a quantity proportional to e.m.f. The e.m.f. of the photovoltaic cell increases with the concentration of the electrolyte. AUTHOR.

3601. Kathodic Polarisation of Mercury. E. Spitalsky and N. I. Nekrassow. *Zeits. f. phys. Chem.* 147. *Abt. A.* 5. *pp.* 321–344, *May*, 1930.

The dependence of the polarisation of a mercury electrode on a number of factors, such as current density, time of polarisation, hydrogen-ion concentration, presence of dissolved oxygen in solution was investigated as completely as possible. The measurements were made by parallel and a commutated method. Two varieties of overvoltage were shown by mercury, but the third variety, found by Newbery, was shown to be due to defects in Newbery's method and did not exist. Traces of oxygen brought about rapid depolarisation of the mercury and led to false results. The deposition of an extremely small amount of hydrogen, sufficient to form a layer one molecule thick, was sufficient to produce the potential. This fact is not in accord with the existence of gas films. F. J. B.

3602. Electrolytic Polarisation. Part IX. Complex Cyanides: Zinc, Cadmium and Mercury. S. Glasstone. *Chem. Soc., J. pp.* 1237–1247, *May*, 1930.

It is shown experimentally that $Zn(CN)_4''$ is probably the chief complex ion in a zinc sulphate solution with sodium cyanide. The actual kathode potentials and current efficiencies observed are in agreement with the predictions made from a study of the titration curve. All the results can be explained without assuming that the complex zincicyanide ion dissociates *slowly* into its constituents. It appears possible that, as in the case of silver, a complex zinc cyanide kation, possibly $[Zn_2(CN)_2]^{\cdot\cdot}$ is formed, and that such complex ions rather than simple zinc ions may be discharged at the kathode in electrolysis. These results, and those obtained with cadmium and mercury, show that the main factors concerned are the variation of the electrode potential with increasing ratio of cyanide to metal, the potential for hydrogen evolution at the given metal, and the concentration of the electrolyte. Electrometric titration curves indicate the presence of $Cd(CN)_3'$ and $Cd(CN)_4''$ ions in cadmium solutions, and $Hg(CN_3)'$ and $Hg(CN)_4''$ ions in mercuric solutions. [See also Abstract 2871 (1929).] H. N. A.

3603. Electrochemical Reactions of Tungsten, Thorium, Cæsium and Oxygen. I. Langmuir. *Indust. and Engin. Chem.* 22. *pp.* 390–393, *April* 1, 1930.

A review of the work of the author and his collaborators on the thermionic properties of tungsten surfaces, both when clean and when covered with films of thorium, cæsium and oxygen. F. J. W.

3604. Electrolytic Deposit of Copper in Presence of Amido-Acids. C. Marie and Gérard. *Comptes Rendus*, 190. *pp.* 864–866, *April* 7, 1930.

Copper deposited by electrolysis in presence of gelatin includes a certain quantity of this colloid as well as hydrated copper sulphate. The influence of glycocoll, which provokes surcharge, was studied. It was found that the surcharge diminishes when the current density diminishes, passing from 2·35 % for a current density of 4 amperes. per sq. dm. to 0·49 % for 1 ampere. The surcharge diminishes with the proportion of glycocoll in the electrolyte, varying from 4·17 % to 1·57 % for concentrations of 0·1 and 0·01 gm. mol. per litre respectively. When the *p*H of the solution varies from 2·5 to 1·20, the surcharge passes from 2·35 % to 0·55 %. It disappears for a *p*H of 0·38. The variations of concentration in $CuSO_4$ when they are between 2*N* and *N* are without notable influence on the surcharge. The copper precipitated under these conditions brings with it copper sulphate and glycocoll. The relative proportions vary little and the ratio is about the molecular ratio (2·13). J. J. S.

3605. Calculation of Activity Coefficients from Solubility Measurements. Thallous Chloride. H. E. Blayden and C. W. Davies. *Chem. Soc., J. pp.* 949–956, *May*, 1930.

The solubility measurement of one salt in the presence of others is shown to require correction for incomplete dissociation when the results are used to calculate the activity coefficients. The necessary corrections are made for thallous chloride and it is shown that the logarithm of the activity coefficient gives a straight line when plotted against the square root of the ionic strength up to 0·1 *N*. The slope of the curve was found to be 0·38, not 0·505 as required by the Debye-Hückel theory. The dissociation constant of the $TlSO_4'$ ion was found to be 0·036, and that of thallous chlorate to be 0·34. F. J. B.

3606. Nature of Electrolytic Dissociation. M. Rabinowitsch. *Zeits. f. phys. Chem.* 147. *Abt. A.* 5. *pp.*. 345–370, *May*, 1930.

The data at present available indicate that complete ionisation of strong electrolytes cannot be accepted, and that pure electrostatic treatment of the electrolytic dissociation is not in agreement with the nature of the phenomenon. Consideration of the electrical conductivity of molten salts, solid electrolytes and solutions indicates the predominance of the influence of molecular polarisation or of intramolecular ionisation over that of electrolytic dissociation. The function of the dielectric constant of the solvent and, with solutions, the chemical interaction of the components of the solution must also be taken into account. The interpretation thus reached for the so-called anomalous electrical conductivity leads to the assumption that the mechanism of conduction in solutions is of two kinds: transference of charge by means of ionic migration through the solution, this predominating in dilute solutions, and by change in position of the ions in the interior of a complex molecular aggregate, analogous to ionic conductivity in crystals, this occurring mainly in concentrated solutions. T. H. P.

3607. New Glass Electrode System. C. Morton. *Journ. Sci. Instruments*, 7. *pp.* 187–190, *June*, 1930.

A new glass-electrode system, making use of high conductivity glass, is described. The e.m.f. is measured by a ballistic method. Electrostatic shielding and exceptional care in insulation are unnecessary, and determinations of hydrogen-ion concentration can be made in ½–1 min. with an accuracy of ± 0·01 *p*H. AUTHOR.